Radiological and Nuclear Emergency Plan

September 11, 2019
Revision 2

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INCIDENT ANNEX X

RADIOLOGICAL AND NUCLEAR EMERGENCIES

Vermont State Emergency Management Plan (SEMP)
September 11, 2019 Incident Annex x (Revision 2)

LEAD: Vermont Department of Health (VDH)

SUPPORT: Agency of Human Services (AHS); Department of Public Safety (DPS) including Vermont Emergency Management (VEM), the Homeland Security Unit (VHSU), Vermont State Police (VSP), and Division of Fire Safety (DFS); Agency of Natural Resources (ANR) Department of Fish and Wildlife (DFW) and Department of Environmental Conservation (DEC); Agency of Transportation and its Department of Motor Vehicles (DMV); Agency of Agriculture, Food and Markets (VAAFM); Vermont National Guard 15th Civil Support Team (CST); the New England Radiological Health Committee (NERHC); U.S. Department of Energy (DOE); U.S. Environmental Protection Agency (EPA); U.S. Federal Emergency Management Agency (FEMA); U.S. Centers for Disease Control and Prevention (CDC); U.S. Department of Homeland Security (DHS); and U.S. Nuclear Regulatory Commission (NRC).

I. INTRODUCTION

1. The purpose of this annex is to describe the essential actions to prevent and respond to a radiological or nuclear emergency, and to define the parties responsible for those actions.

2. The scope of this annex includes:

    a. Preventing radiological or nuclear incidents by early detection and interdiction of illicit radioactive or nuclear materials, and

    b. Response to incidents that result in the release of solid, liquid or airborne radioactive materials that may pose a public health threat. Incidents include

        i. Air, ground, rail, waterway and space vehicle transportation accidents accompanied by the release of radioactivity or radiation exposure;

        ii. Fires involving radioactive materials;

        iii. The discovery of orphan radioactive sources; and

        iv. Intentional, criminal or terrorist acts:

            1. A radiological dispersal device (RDD) including a dirty bomb,

            2. An improvised nuclear device (IND) or other nuclear detonation,

            3. A radiological exposure device (RED), and

4. The introduction of radioactive materials into public media (food or water supplies, public gatherings, building ventilation systems or mail services).

3. This annex may be supportive of Incident Annex 9A to the State of Vermont Emergency Operations Plan (SEOP) for incidents at the Vermont Yankee and Yankee Rowe fixed nuclear facilities. Vermont Yankee is a shutdown nuclear reactor with an independent spent fuel storage installation (ISFSI), while Yankee Rowe is an ISFSI alone.

4. The guidance incorporated into this annex does not supersede requirements in other plans, particularly those of law enforcement organizations. The guidance in this annex is designed to supplement those requirements by focusing on public health protection responses.

II. ASSUMPTIONS AND BACKGROUND INFORMATION

1. It is impossible to provide guidance for all kinds of radiological or nuclear emergencies.

    a. The advice of technical experts will be used to effectively deal with issues not described in this annex.

        i. The Radiological Operations Support Specialist (ROSS) is a radiological and nuclear emergency response and recovery subject matter expert.

        ii. Their training and qualification prepare them for all rad/nuc incidents including catastrophic incidents like a nuclear detonation.

        iii. The VDH has a Type 1 ROSS and seeks to train additional Type 3, 2 and 1 ROSS (Type 1 is the highest qualification).

        iv. ROSS are trained in other States, including those of the New England Radiological Health Conference (NERHC) and may be requested as mutual aid. They may be requested by contacting the ROSS Steering Committee at FEMA.

        v. The New England Interstate Radiation Assistance Plan, usually referred to as the New England Compact and discussed below, may also be used to obtain other radiological assistance.

    b. There also exists guidance in other annexes to the SEOP and within the VDH to address specific issues more thoroughly. These plans will be referred to in this annex, and the user of this annex should use those plans as necessary. Guidance from outside subject matter experts is also referenced throughout this plan.

    c. The prevent mission of the Preventive Radiological/Nuclear Detection (PRND) Program is critical.

        i. It is managed by the Vermont Homeland Security Unit of the Department of Public Safety.

        ii. The Radiological Sciences Program coordinates technical content of the PRND program through its membership on the PRND Steering Committee and Operations Working Group.

        iii. It is described in the State of Vermont Preventive Radiological/Nuclear Detection (PRND) Concept of Operations (CONOPS), 2015.

        iv. There are numerous standard operating procedures (SOPs) that describe how the PRND Program is implemented by different agencies. A particularly useful SOP for VDH is that of the Vermont Hazardous Materials Response Team (VHMRT) SOP.

v. The PRND Program is designed and managed to help prevent radiological incidents both in Vermont and elsewhere in the United States by detecting and interdicting illicit materials before misuse.

d. Guidance of the National Council on Radiation Protection and Measurements (NCRP) is the basis of much of the content in this plan and may be useful for background reading.

i. *Advising the Public About Radiation Emergencies,* NCRP Commentary No. 10, 1994.

ii. *Management of Terrorist Events Involving Radioactive Material*, NCRP Report No. 138, 2001.

iii. *Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism*, NCRP Commentary No. 19, 2005.

iv. *Management of Persons Contaminated with Radionuclides*, NCRP Report No. 161, 2008.

v. *Radiation Dose Reconstruction: Principles and Practices,* NCRP Report No. 163, 2009.

vi. *Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers*, NCRP Report No. 165, 2010.

vii. *Decision Making for Late-Phase Recovery from Major Nuclear or Radiological Incidents*, NCRP Report No. 175, 2014.

viii. *Guidance for Emergency Response Dosimetry,* NCRP Report 179, 2017.

ix. *Implementation Guidance for Emergency Response Dosimetry,* NCRP Commentary 28 (2019).

e. Other guidance has been used for this plan and it should be reviewed and understood by Vermont radiological and nuclear emergency preparedness leadership. It includes:

i. Environmental Protection Agency, *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*, 2017. Available at: https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf.

ii. National Security Staff Interagency Policy Coordination Subcommittee for Preparedness & Response to Radiological and Nuclear Threats, *Planning Guidance for Response to a Nuclear Detonation*, Second Edition, 2010. Available at: https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation__2nd_edition_final.pdf.

iii. Department of Homeland Security, Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans, 2016. Available at: https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf.

iv. Department of Homeland Security, *Radiological Dispersal Device (RDD) Response Guidance Planning for the First 100 Minutes*, 2017. Available at: https://www.dhs.gov/sites/default/files/publications/NUSTL_RDD-ResponsePlanningGuidance-Public_171215-508.pdf.

v. RadResponder provides the ROSS Toolkit in its resource library, and it has what has been assessed as the best science-based guidance currently available for perimeters and zones, population monitoring, recovery resources, worker safety and shelter and evacuation.

vi. Medical Planning and Response Manual for a Nuclear Detonation Incident: A Practical Guide, United States Department of Health and Human Services, 2012. https://www.phe.gov/Preparedness/planning/nuclearresponsemanual/Documents/medplanresmannucdet-guide-final.pdf

vii. Glasstone, Samuel and Dolan, Philip J., *The Effects of Nuclear Weapons,* Third Edition, United States Department of Defense and Energy Research and Development Administration, Washington, DC, 1977.

2. Local emergency responders are likely to be the first on scene, and they could identify the incident as potentially or actually involving radioactive materials or materials of unknown risk, which would include risk of radioactive materials. These initial responders may include local fire or police departments, other law enforcement agencies or emergency medical services. Initial reports may be provided by a member of the public, as well.

3. Occupational radiation protection regulations do not currently adequately address radiation doses for emergency responders.

    a. In some emergencies, workers from regulated entities may be able to respond and their dose may be manageable using occupational radiation standards, for example maintaining whole body doses to less than 50 millisievert (5000 millirem) per year. Regulated entities maintain dose management responsibilities for their workers during such emergencies.

    b. In other emergencies, for example a nuclear detonation, responder doses for lifesaving operations may exceed occupational limits.

        i. Regulated entities will need guidance from government authorities on radiation dose decision points for their workers (note that the term “limits” is not used here).

ii. Some emergency responders may include people who do not work for regulated entities.

    1. Government authorities must assume radiation protection responsibility for these people.

    2. These people could have roles as varied as firefighters and emergency medical technicians to emergency vehicle operators and utility workers.

    3. When emergency responders are engaged in lifesaving activities and there exists no responsible party, as in an act of war or an act of terrorism, the State of Vermont will assume radiation protection responsibility for emergency responder health and safety, including radiation dose monitoring.

iii. The NCRP recommends that incident commanders retain their authority to determine whether responders should engage in lifesaving activities, including when radiation dose may exceed occupational limits.

    1. Every effort must be taken to maintain emergency responder dose as low as reasonably achievable.

    2. Where guidance exists, for example in the Environmental Protection Agency's (EPA) Protective Action Guidelines (PAGs), these values may serve as good decision points for radiation dose management during lifesaving actions. See Table 1 below.

    3. The VDH must provide incident commanders with guidance as to other radiation doses and their effects, so incident commanders can better determine whether responders are authorized to engage in lifesaving actions. Acute and chronic dose effects guidance is provided in Table 2 below. This could be used to help Incident Commanders determine whether lifesaving actions are justifiable.

Table 1: EPA Protective Action Guidelines for Emergency Worker Dose

Guideline	Activity	Condition
5 rem (50 mSv)	All occupational exposures	All reasonably achievable actions have been taken to minimize dose.
10 rem (100 mSv)[a]	Protecting critical infrastructure necessary for public welfare (e.g., a power plant)	Exceeding 5 rem (50 mSv) unavoidable and all appropriate actions taken to reduce dose. Monitoring available to project or measure dose.
25 rem (250 mSv)[b]	Lifesaving or protection of large populations	Exceeding 5 rem (50 mSv) unavoidable and all appropriate actions taken to reduce dose. Monitoring available to project or measure dose.
>25 rem (250 mSv)	Lifesaving or protection of large populations	All conditions above and only for people fully aware of the risks involved (see Tables 3-2 and 3-3)

[a] For potential doses >5 rem (50 mSv), medical monitoring programs should be considered.

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

This guidance does not address or impact site cleanups occurring under other statutory authorities such as the United States Environmental Protection Agency's (EPA) Superfund program, the Nuclear Regulatory Commission's (NRC) decommissioning program, or other federal or state cleanup programs.

These guidelines are not regulations but may well serve as decision points for incident commanders responsible for evaluating the totality of the circumstances at a scene where lifesaving operations may be complicated by radiation exposure. Additional guidance is provided by the NCRP in Reports 165 and 170 where a 0.5 Gy (50 Rad) dose is recommended as a decision point. The decision point is a term used here to replace what has often been called a turn-back value. Using decision point reinforces that an automatic retreat is not required, informed risk assessment and analysis of the benefits gained by potentially “once in a lifetime” higher radiation exposure.

Table 2: Acute Effects Table for Incident Commander Guidance

Effect	Dose	Risk	Time to Develop Effect
Increased stochastic risk of cancer and heritable effects	1 sievert (Sv) whole body dose	Approximately 4 - 6% increased risk of cancer per Sv	Years
Bone marrow syndrome without good medical care	~1 gray (Gy) dose to bone marrow	Approximately 1% incidence from acute dose of 1 Gy to bone marrow	30 – 60 days
Bone marrow syndrome with medical care	2 - 3 gray (Gy) dose to bone marrow	Approximately 1% incidence from acute dose of 1 Gy to bone marrow	30 – 60 days
Gastrointestinal syndrome without good medical care	~6 gray (Gy) dose to small intestine	Approximately 1% incidence from acute dose of ~6 Gy to small intestine	6 – 9 days
Gastrointestinal syndrome with medical care	> 6 gray (Gy) dose to small intestine	Approximately 1% incidence from acute dose of > 6 Gy to small intestine	6 – 9 days
Pneumonitis	7 – 8 gray (Gy) dose to lung	Approximately 1% incidence from acute dose of 7 – 8 Gy to lung	1 – 7 months
Cardiovascular disease from whole body exposure	~0.5 gray (Gy) to heart	Approximately 1% incidence from acute dose of ~0.5 Gy to heart	>10 – 15 years
Cerebrovascular disease	~0.5 gray (Gy) to carotid artery	Approximately 1% incidence from acute dose of ~0.5 Gy dose to carotid artery	> 10 years

Adapted from Table 4.5 of International Commission on Radiological Protection (ICRP) Publication 118, *ICRP Statement on Tissue Reactions and Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context*, 2012 and Table 1 of ICRP Publication 103, *The 2007 Recommendations of the International Commission on Radiological Protection*, 2007. One sievert = 100 rem and 1 gray = 100 rad.

This guidance may help incident commanders understand the risk presented to their responders in undertaking lifesaving activities. It must be recognized that the totality of circumstances the incident commander must weigh in decision-making may include risks more significant than radiation exposure, too.

4. Communicating directly with the public in language they can relate to with guidance as to what they can and should not do during the emergency is critical to successful response and a more effective recovery. Communicating radiation information during an emergency may cause confusion if not planned carefully.

    a. Pre-written templates that have been assessed for communication quality (including possible translation for English language learners) are useful. References to create these templates and other communications include:

        i. *Communicating Radiation Risks – Crisis Communications for Emergency Responders*, EPA 2008. Available at: https://www.epa.gov/radiation/pag-public-communication-resources.

        ii. *Improvised Nuclear Device Response and Recovery – Communicating in the Immediate Aftermath*, FEMA 2013. Available at: https://www.fema.gov/media-library-data/20130726-1919-25045-0892/communicating_in_the_immediate_aftermath__final_june_2013_508_ok.pdf.

        iii. *Communicating During and After a Nuclear Power Plant Incident*, FEMA 2013. Available at: https://www.fema.gov/media-library-data/20130726-1919-25045-1433/communicating_during_and_after__npp_incident___june_2013__secure_.pdf.

    b. Radiological units can add to confusion.

        i. Simplicity may be best, rather than scientific exactitude, in some communications, especially with the public and untrained responders. It may be better to use comparisons to background radiation levels rather than radiological units. The CDC has a one to five Radiation Hazard Scale that may be effective (Figure 1). It and links to other useful information may be found at: https://www.cdc.gov/nceh/radiation/emergencies/radiationhazardscale.htm.

        ii. Some agencies, especially outside the United States, use System International (SI) units. Coordination among agencies, including on units to use, is vital to maintaining a common radiological operating picture.

            1. Within the SI units, it is common for the gray (Gy) to be used for high doses and organ doses, while the sievert (Sv) is used for effective dose weighting the type of radiation and tissue impacted.

            2. This document uses SI units with English units of Rad and Rem in parentheses.

        iii. The CDC uses a radiation thermometer to help some people understand radiation doses, both in Sv and Rem. Available at: https://emergency.cdc.gov/radiation/radiationthermometer.asp.

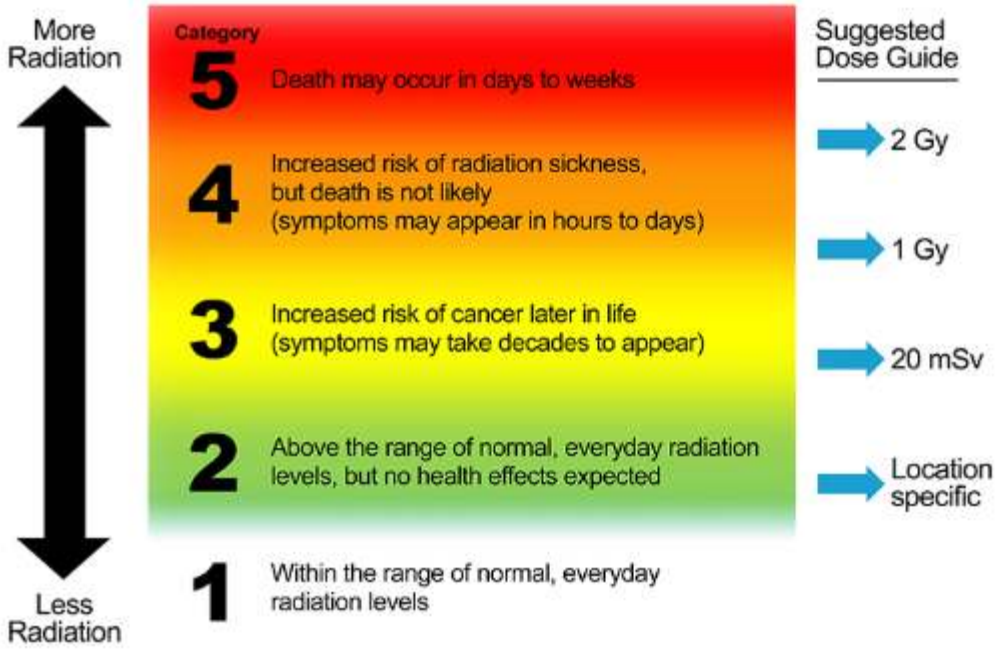
Figure 1: CDC Radiation Hazard Scale

Suggested Guide on How to Assign Radiation Hazard Categories

The Radiation Hazard Scale is intended to communicate relative hazards to populations under emergency conditions when exact radiation exposure parameters for specific individuals are not available. Note that:

- There are no sharp lines separating radiation hazard categories.
- Transition from Category 1 to Category 2 depends on the range of natural background radiation for a geographic area.
- The radiation dose values are whole-body doses and are suggested guides for radiation protection purposes. Dose values are meant to be used by radiation protection experts and emergency response or public health authorities. For a description of radiation units listed in the dose guide, see Primer on Radiation Measurements.
- Radiation dose values are not meant to be included in public messaging, especially during early phase of a radiation emergency.

This guide is applicable for short-term exposure durations, for example, over a period of several days during an emergency.



Example Uses of Radiation Hazard Scale in Emergency Communication Messages

Examples after a nuclear detonation:

- In areas where the Radiation Hazard Category is 5, sheltering in place can help maintain a Category 2 or 3 until instructed to evacuate. In contrast, self-directed evacuation in fallout areas can place a person at Category 4 or 5.
- If people are contaminated with nuclear fallout, self-decontamination can rapidly decrease radiation hazard from Category 5 to Category 2 or 1.

Description of the Radiation Hazard Scale Categories

Category	Description
5	**Category 5** means that radiation doses are dangerously high and potentially lethal. High doses of radiation can cause massive damage to organs of the body and kill the person. The exposed person loses white blood cells and the ability to fight infections. Diarrhea and vomiting are likely. Medical treatment can help, but the condition may still be fatal in spite of treatment. At extremely high doses of radiation, the person may lose consciousness and die within hours. For more information, see https://www.remm.nlm.gov/ars_summary.htm
4	**Category 4** means that radiation doses are dangerously high and can make people seriously ill. Radiation doses are not high enough to cause death, but one or more symptoms of radiation sickness may appear. Radiation sickness, also known as Acute Radiation Syndrome (ARS), is caused by a high dose of radiation. The severity of illness depends on the amount (or dose) of radiation. The earliest symptoms may include nausea, fatigue, vomiting, and diarrhea. Symptoms such as hair loss or skin burns may appear in weeks. For more information about the health effects of radiation, see http://emergency.cdc.gov/radiation/healtheffects.asp For more information about medical treatment of radiation exposure, see http://emergency.cdc.gov/radiation/countermeasures.asp
3	**Category 3** means that radiation doses are becoming high enough where we may expect increased risk of cancer in the years ahead for people who are exposed. Leukemia and thyroid cancers can appear in as few as 5 years after exposure. Other types of cancer can take decades to develop. Studies have shown that radiation exposure can increase the risk of people developing cancer. This increased risk of cancer is typically a fraction of one percent. The lifetime risk of cancer for the population due to natural causes is approximately 40%. The increase in risk of cancer from radiation depends on the amount (or dose) of radiation, and it becomes vanishingly small and near zero at low doses of radiation. For more information, see http://emergency.cdc.gov/radiation/cancer.asp
2	**Category 2** means that radiation levels in the environment are higher than the natural background radiation for that geographic area. However, these radiation levels are still too low to observe any health effects. When radiation levels are higher than what we normally have in our natural environment, it does not necessarily mean that it will cause us harm. For more information about health effects of radiation, see https://www.cdc.gov/nceh/radiation/health.html
1	**Category 1** means that radiation levels in the environment are within the range of natural background radiation for that geographic area. Low amounts of radioactive materials exist naturally in our environment, food, air, water, and consequently in our bodies. We are also exposed to radiation from space that reaches the surface of the Earth. These conditions are natural, and this radiation is called the natural background radiation. For more information about radiation and radioactivity in everyday life and how it can vary by location, see https://www.cdc.gov/nceh/radiation/sources.html

5. The Vermont Hazardous Materials Response Team (VHMRT) would typically be requested by the local incident commander following identification of unknown hazardous materials or actual or potential radioactive materials involvement.

    a. They may also be deployed as part of the State's response to a radiological or nuclear incident.

    b. The VHMRT is trained to serve as radiological/nuclear incident field responders by VDH and others.

    c. The VHMRT possesses multiple beta-gamma and gamma survey instruments, personal dosimetry, radioisotope identification detectors (RIIDs) and portable high-volume air samplers.

    d. The VDH Radiological Sciences Program will provide technical and health-related guidance to the VHMRT in its role as radiological/nuclear incident field responders. This guidance is provided before incidents for training purposes, during incidents as Technical Specialists, and after incidents to assist with recovery, after action review and corrective action plans.

6. The VDH may activate its Health Operations Center (HOC) for command and control of the public health response using its VDH Emergency Operations Plan. It is critical that the SEOC and VDH maintain a common radiological operations picture.

7. A VDH employee will serve as the Health Department liaison between the HOC and SEOC.

8. VDH will provide the SEOC a Technical Specialist to serve under the Incident Manager. At the SEOC, this person fills the role of the Radiological Health Advisor and signs in as such,

    a. The Radiological Health Advisor is responsible for providing radiological and nuclear emergency subject matter expertise to all elements of the incident management team and to incident command posts as they seek it.

    b. The Radiological Health Advisor will provide resources to:

        i. Work to facilitate a common operating picture for radiological and nuclear emergencies;

        ii. Assist the Public Information Officer (PIO) with communications regarding radiological health protective guidance;

        iii. Make recommendations for protective actions for the public and for responders;

        iv. Help emergency support functions and other elements of the incident management team perform their duties effectively in the complex conditions of radioactive contamination and radiation dose;

v. Provide guidance to protect the health and safety of emergency workers and provide guidance on the health, physical and environmental impacts of the incident;

1. A zoned approach is suggested by the NCRP and others.

a. Responders often use hot, warm and cold zones:

i. The hot zone is where exposure to the agent must be controlled;

ii. The cold zone is where exposure to the agent is unlikely or without significant consequence;

iii. The warm zone is transition space from the cold zone into the hot zone and where responder monitoring and decontamination occurs.

b. The NCRP defines the hot zone as where the external radiation dose rate is > 100 μSv/h (10 mR/h).

c. The NCRP further delineates a dangerous radiation zone at > 100 mGy/h (10 Rad/h). (Note that these chronically hazardous radiation dose rates are defined in Sv/h, where acutely hazardous dose rates are referred to in Gy/h or Rad/h).

d. For an RDD, the DHS recommends a 250 m radius hot zone, 500 m radius shelter-in place zone and 2000 m downwind shelter-in-place zone as depicted in Figure 2.

e. For nuclear detonations, Federal Guidance and the NCRP define four additional zones (See Figure 3):

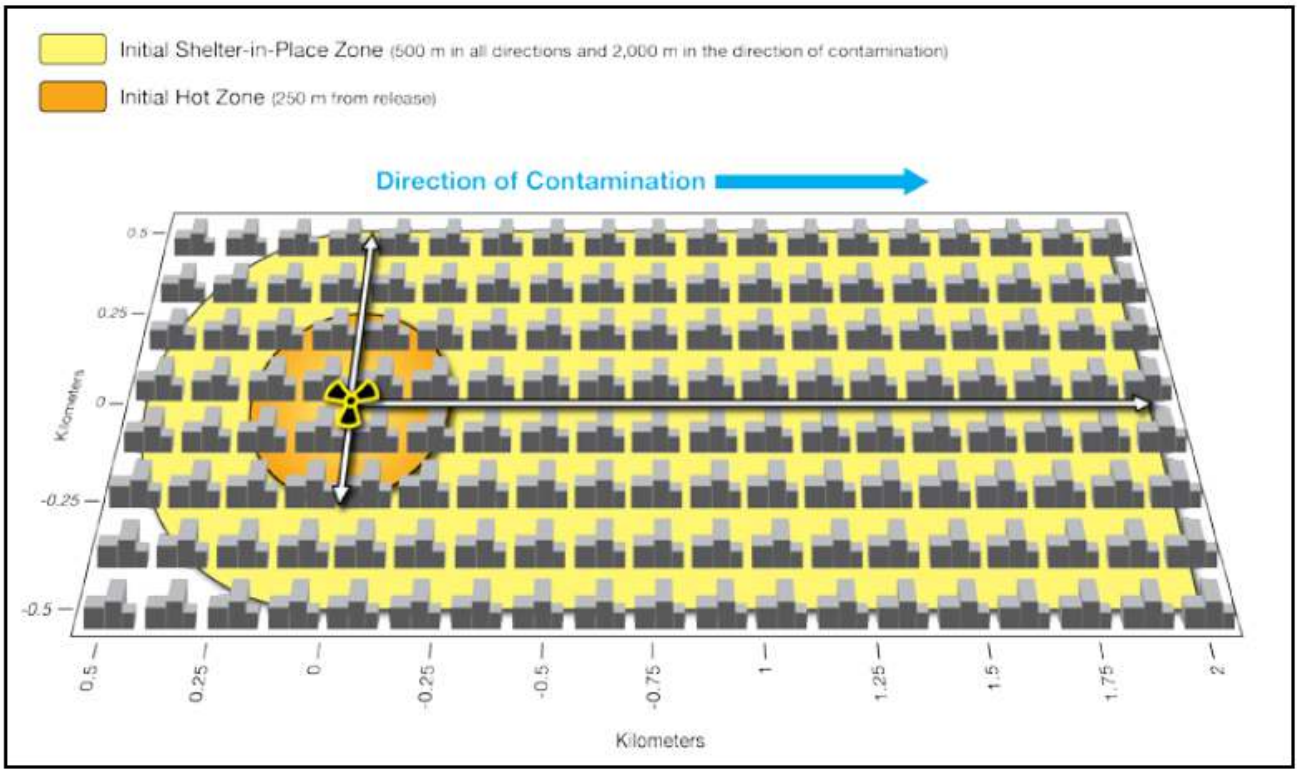
i. The severe damage zone where survival from blast, thermal and ionizing radiation effects is unlikely;

ii. The moderate damage zone where survival of those exposed depends on their being provided prompt care for trauma and acute radiation sickness (ARS);

iii. The light damage zone where most casualties can attend to their own care and survive;

iv. The dangerous fallout zone the time-dependent area where fallout has deposited and results in radiation levels > 100 mGy/h (10 Rad/h);

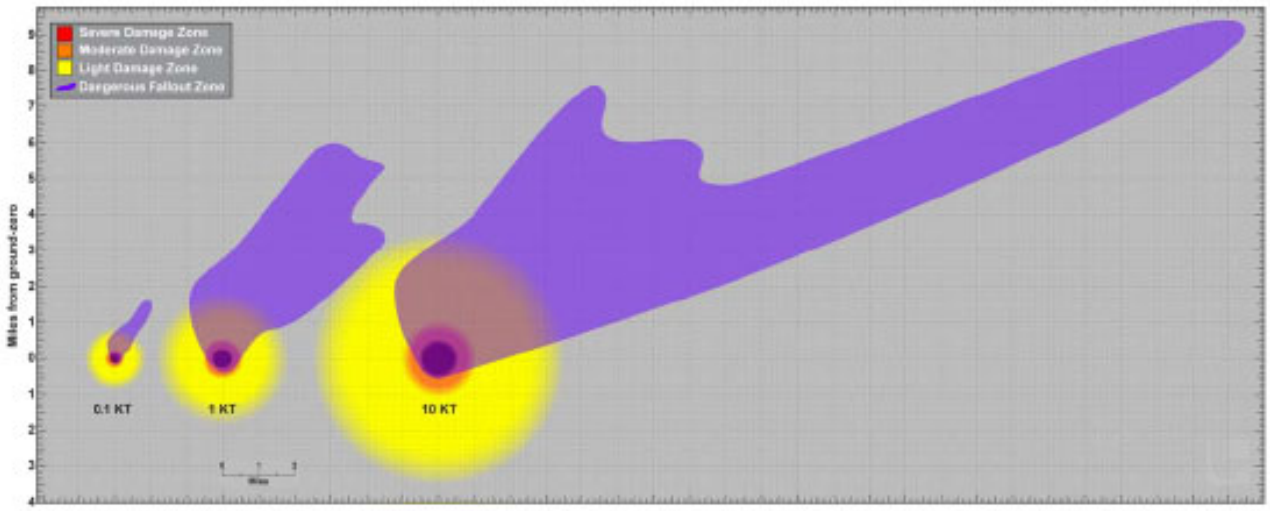
Figure 2
DHS RDD Response Zones



Taken from DHS *Response Guidance for Radiological Dispersal Device (RDD) in the First 100 Minutes*, 2017.

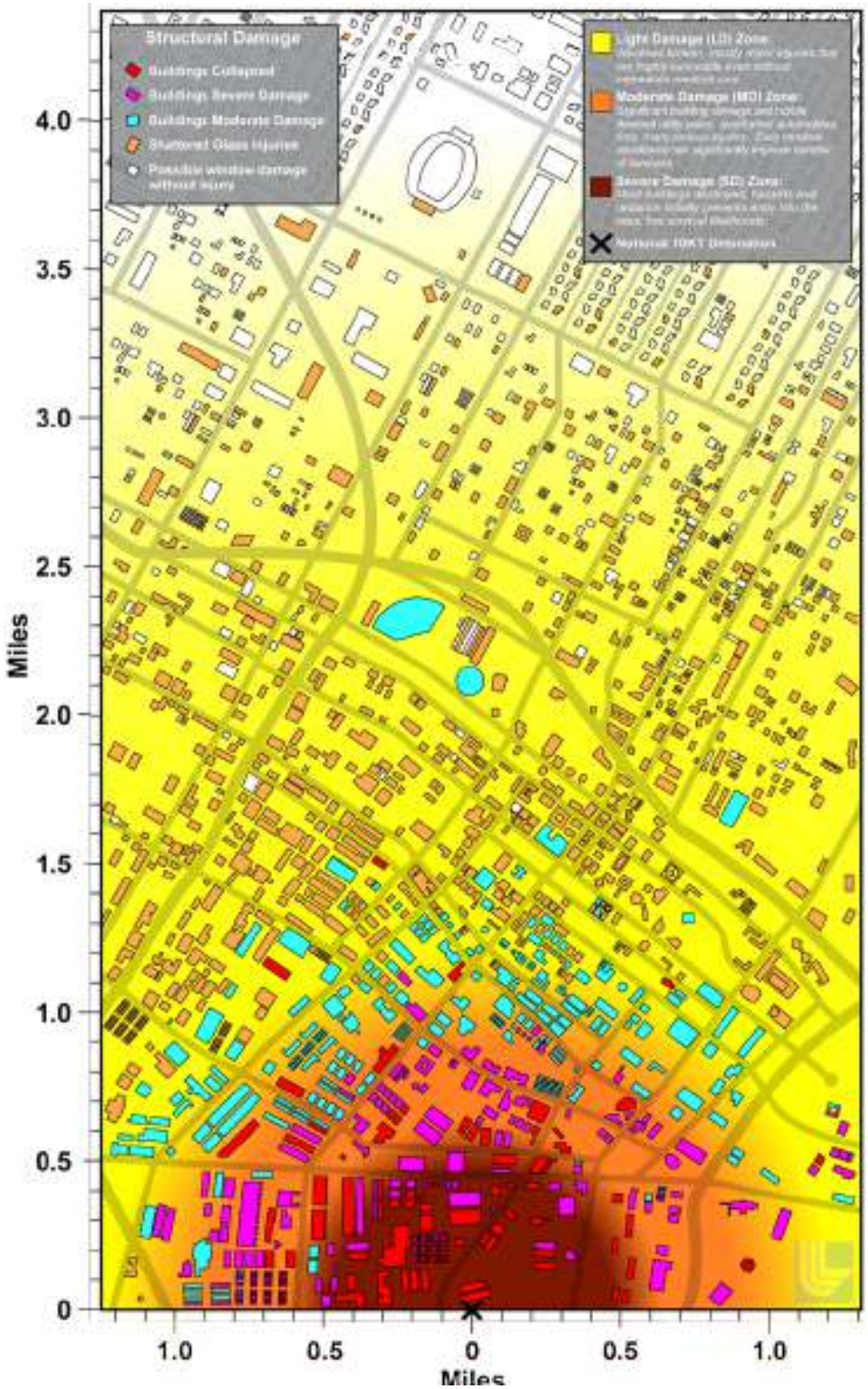
Figure 3

DHS Nuclear Detonation Planning Guidance
Zoned Approach



This figure shows the general nature of the sever, moderate and light damage zones which are the result of prompt effects: blast overpressure, thermal radiation and prompt ionizing radiation – as well as the effects of fallout for three yields of improvised nuclear detonation devices.

The figure below describes more accurately how the three damage zones may be found in an urban area from one yield. The descriptions of damage in the second figure may be useful for segregating areas in actual situations where the true yield is unknown, especially at the earliest stages. Both graphics taken from Planning Guidance for Response to a Nuclear Detonation, Second edition, 2010.


Structural Damage
Buildings Collapsed
Buildings Severe Damage
Buildings Moderate Damage
Shattered Glass Injuries
Possible window damage without injury
Light Damage (LD) Zone:
Moderate Damage (MD) Zone:
Severe Damage (SD) Zone:
Nuclear TOKT Detonation
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
Miles
1.0
0.5
0
0.5
1.0
Miles

vi. Assist the VHMRT and other responders with their strategic and tactical response and recovery operations;

1. It will be useful to establish a single point of contact with the VHMRT. This may be a member of the Radiological Assessment Science Team communicating with an on-scene VHMRT member.

2. In many circumstances, numerous entities may be supporting or working with the VHMRT and using the liaison for Hazardous Materials at the SEOC may be more effective.

3. Remember that on-scene responders will be busy implementing actions and may be working with scarce resources and in austere conditions.

vii. Manage the work of the Radiological Assessment Science Team;

1. The Radiological Assessment Science Team may be collocated with the incident management team at the SEOC or remotely located at the VDH HOC.

2. The Team must be capable of working wherever they physically setup, including from more remote locations during incidents with severe environmental and infrastructure consequences.

viii. Recommend mutual aid requests for additional resources from other jurisdictions, including the New England Radiological Health Committee through the New England Interstate Radiation Assistance Plan (the New England Compact). These requests may be for additional:

1. Assessment Scientists, Federal Radiological Monitoring Assessment Center- (FRMAC) trained radioactive release modeling and radiation dose projection specialists;

2. Radiation protection technicians; and

3. Radiological Operations Support Specialists (ROSS) who are FEMA-Certified and NIMS-Typed radiological and nuclear emergency subject matter experts.

ix. Coordinate with Federal radiological and nuclear emergency response resources including those of the:

1. Department of Energy (DOE)

a. National Nuclear Security Administration (NNSA),

b. Federal Radiological Monitoring Assessment Center (FRMAC),

c. Radiological Assistance Program (RAP),
d. Consequence Management Home Team (CMHT),

e. Consequence Management Response Team (CMRT),

f. Aerial Measuring System (AMS), and

g. National Atmospheric Release Advisory Center (NARAC) through the DHS Interagency Modeling Atmospheric Advisory Center (IMAAC);

2. Environmental Protection Agency (EPA)

   a. Airborne Spectral Photometric Environmental Collection Technology (ASPECT), and

   b. Radiological Emergency Response Team (RERT);

3. Department of Defense (DOD)

   a. Joint Task Force-Civil Support (JTF-CS),

   b. State National Guard Homeland Response Force (HRF) and CBRNE Enhanced Force Packages (CERFP), and

   c. US Marine Corps Forces Command-Chemical Biological Incident Response Force (CBIRF);

4. Department of Homeland Security (DHS)

   a. The Science and Technology Directorate's National Urban Security Technology Laboratory (NUSTL) provides responder guidance for radiological and nuclear emergencies, including:

      i. ROSS Job Aids found on RadResponder

      ii. Radiological Dispersal Device (RDD) Response Guidance (DHS 2017).

      iii. Using PRND Equipment for Consequence Management Missions (DHS 2017).

   b. The Countering Weapons of Mass Destruction Office supports the PRND, their original mandate within the Domestic Nuclear Detection Office, and consequence management.

   c. The Integrated Consortium of Laboratory Networks;

d. The Interagency Modeling Atmospheric Advisory Center (IMAAC), the official coordinating entity for chemical, biological, radiological and nuclear atmospheric release modeling.

5. Federal Emergency Management Agency (FEMA) Chemical Biological Radiological Nuclear (CBRN) Consequence Management Advisory Team and/or Radiological Emergency Program (REP);

6. Department of Health and Human Services (DHHS)

    a. Centers for Disease Control and Prevention (CDC) Radiation Studies Branch,

    b. Radiation Emergency Medical Management (REMM), and

    c. Radiation Injury Treatment Network (RITN); and

7. The Interagency Advisory Team for Environment, Food and Health for radiological and nuclear emergency subject matter experts from the EPA, United States Department of Agriculture (USDA), Food and Drug Administration (FDA), CDC and other Federal agencies.

8. The Nuclear Regulatory Commission (NRC) especially for nuclear power plant and other radioactive materials incidents.

    a. Note that incidents at Vermont radioactive materials licensees requires notification of the Vermont Department of Health Radioactive Materials Program or RMP (via the Radiation Control Program Director or the Radioactive Materials Program Manager).

    b. Certain radioactive materials incidents must be reported within specific time frames, and some to the NRC as well as the VDH RMP.

9. The Radiological Assessment Science Team is composed of specially trained Assessment Scientists from the VDH and elsewhere.

    a. In the earliest phase of the incident they predict the possible consequences of a radiological or nuclear emergency, and

    b. As real data is obtained from the field teams and from laboratory analysis, they accurately document the public health environmental consequences of the incident.

    c. The Assessment Scientists can model projected and then document actual:

        i. Doses from, and/or concentrations of, airborne radioactive material,

        ii. Doses from, and/or surface contamination levels from, the deposition of fallout,

iii. The geographic extent of deposition or fallout from releases, and

iv. Residual contamination in food, water and other elements of the ingestion pathway to dose.

10. RadResponder has been developed by and is managed by FEMA for the collection and sharing of quality-validated environmental radiological data and is to be used in Vermont radiological and nuclear emergency response and recovery activities.

    a. RadResponder is an internet platform for the management and display of environmental data that is supported by a mobile application that can be used on smart phones and tablets to geolocate actual measurements and sample collection sites.

    b. It can also display where responders are physically located allowing incident managers to visibly track emergency responders in real time.

    c. RadResponder accounts are provided at https://www.radresponder.net/. The Radiation Control Program Director at VDH, currently available at William.irwin@vermont.gov, is the Vermont RadResponder administrator able to invite responders to register in Vermont.

    d. RadResponder is also the website for the ROSS Toolkit. The ROSS Toolkit provides scientifically vetted guidance that can be used for recommendations and decision making in radiological and nuclear emergencies.

    e. RadResponder also provides overlays and other tools which can help planners and response managers, including the ten-point monitoring protocol, radiological dispersal device (RDD) overlays, and the nuclear detonation rapid hazard assessment tool.

11. There exist many resources available for the prevention of, or for response to, radiological and nuclear incidents. They include:

    a. Preventive radiological and nuclear material detection personnel and instrumentation.

        i. Personnel possess personal radiation detectors (PRDs), spectral personal radiation detectors (SPRD) and radioisotope identification detectors (RIIDs) that can be useful in any emergency, though with limitations.

            1. PRDs, SPRDs and RIIDs may be deployed in cold zones for survey of personnel, areas and equipment lightly contaminated with gamma-emitting radioactive materials.

            2. Those with higher range, i.e., greater than 50 µSv/h (5 mR/h), may be useful in hot zones.

            3. Training of these personnel, e.g. with QuickStart training, should remind them of this capability as an extension of their prevent mission into the consequence management mission.

ii. Agencies in the Preventive Radiological Nuclear Detection (PRND) Program besides the Health Department with PRDs and RIIDs are:
    1. The Vermont Department of Motor Vehicles (DMV) Commercial Vehicle Enforcement (CVE) Unit,
    2. The Vermont State Police (VSP),
    3. The Vermont Department of Fish and Wildlife (DFW) game wardens,
    4. The VHMRT, and
    5. The 15th Civil Support Team (CST).

b. Radiological Assessment Science Team and their dose modeling and dose projection procedures, hardware and software;

c. VHMRT radiological emergency response procedures and equipment;

    i. Each technician maintains multiple personal emergency dosimeters (colorimetric cards, RadWatch optically stimulated luminescence dosimeter) and a high range gamma radiation personal radiation detector (Canberra Ultra Radiac Plus).

    ii. Each company (there are currently four, one for each of the four trucks geographically dispersed around Vermont) possesses multiple high range beta-gamma radiation survey meters (CDV-18, RadEye B20-ER), portable DC powered high volume air samplers (F&J Specialty HV1-BC), multiple beta-gamma contamination detectors (Ludlum Model 26), a high range PRD (Canberra AN/UDR-13), and multiple self-reading pocket dosimeters and chargers.

    iii. Each company also has a radioisotope identification detector (Berkeley Nucleonics SAM-940)

    iv. The VHMRT instruments, like those of the VDH, are inventoried in RadResponder.

d. The 15th CST weapons of mass destruction (WMD) responders;

e. Mutual aid from the New England Radiological Health Committee through the New England Interstate Radiation Assistance Plan (NEIRAP);

f. Radiological Operations Support Specialists (ROSS):

    i. ROSS are radiological and nuclear emergency subject matter experts trained and certified by FEMA.

    ii. Vermont has ROSS as do many other states.

iii. Should ROSS in Vermont be exhausted, they can be requested as mutual aid from other states.

iv. The FEMA Chemical, Biological, Radiological and Nuclear (CBRN) Office manages the ROSS Program and can be reached at FEMA-ROSS@dhs.fema.gov.

g. Federal agencies including the DOE, EPA, FEMA, CDC, FDA, NRC, USDA and others.

12. Terrorist or criminal radiological or nuclear incidents will require management by local, state and federal law enforcement agencies. Vermont resources described in this annex will be available to serve under the appropriate command established for these purposes.

13. Some radiological emergencies will rise to the level of being designated a "national level emergency" by the Office of the President and require enhanced Federal management of the response. In these cases, the Vermont resources described in this annex will be available to serve under the appropriate command established to manage the response.

14. Some radiological emergencies within the State of Vermont may require requests for radiological mutual aid through the New England Interstate Radiation Assistance Plan (the New England Compact).

    a. The New England Compact provides mechanisms to obtain radiological protection staff and equipment from the five other New England states.

    b. The New England Compact is governed by statute (18 VSA §§ 1601-1609) created in the Vermont legislature in 1967. Available at: (https://legislature.vermont.gov/statutes/chapter/18/031).

    c. The VDH Commissioner may request this mutual aid via communication with the Secretary of the Compact, the Radiation Control Program Director for the State of Connecticut (860-424-4190).

    d. Radiological protection staff and equipment from Vermont may also be requested as mutual aid by the other five New England States.

15. Some radiological emergencies will cause individual and society-wide behavioral complications such as panic, mistrust of officials, civil disobedience and criminal misconduct.

    a. There may be enhanced demands placed upon physical and mental health care systems and professionals.

    b. These need not be instigated by an incident in Vermont, or even a bordering state, but be the result of a national incident outside of New England or an international incident.

    c. Law enforcement may be required to provide safety where radiological and nuclear emergency resources are deployed.

III. MISSION

1. This annex provides guidance to accomplish objectives to ensure the safety of emergency responders relative to direct radiation exposure, external radioactive material contamination and internal radioactive material intakes.

2. This annex provides guidance to accomplish objectives to minimize public health risks and monitor public health effects from direct radiation exposure, external radioactive material contamination and internal radioactive material intakes.

3. This annex provides guidance to accomplish objectives which minimize radioactive contamination of the environment to prevent radioactive material intakes from the food chain. This includes the protection of surface and ground waters, natural and cultivated vegetation, agricultural livestock and wildlife, soils and sediments and animal and human foodstuffs in various locations of their distribution networks.

4. This annex provides guidance to accomplish objectives for environmental restoration or establishment of restricted areas. Restricted areas would require specific limitations on access and use of materials from these restricted areas.

5. This annex provides guidance on recovery following a radiological or nuclear emergency.

6. This annex integrates the preventive radiological and nuclear detection program and the radiological and nuclear consequence management program.

IV. CONCEPT OF OPERATIONS

1. The principles of the incident command system (ICS) and the National Incident Management System (NIMS) will guide emergency organizational structure and response. It is expected that Local, State and federal resources may establish unified command for certain radiological emergencies.

2. Responsible entities will use the guidance of this annex to manage the radiological or nuclear emergency response but have the latitude necessary to use expert guidance where this annex does not address the specific needs of the moment.

3. Critical activities undertaken in response to a radiological emergency should be documented in writing. The forms attached to this annex are recommended for this purpose.

4. VDH operations managed through this annex are done in compliance with the current revision of the VDH Emergency Operations Plan.

5. Operations identified in this annex that are under the control of entities outside of the VDH should be managed in compliance with the current guidance available to those entities. The VDH will provide comment on this guidance as requested by these entities.

V. SUPPORTING ACTIONS

1. Preparedness Actions

    a. The VDH must periodically evaluate its capabilities for radiological emergency response and continuously support staff inside and outside of the VDH for their roles in this preparedness effort. One part of the evaluation is maintenance of this annex through periodic revision.

    b. The VDH Laboratory must maintain its capabilities to analyze alpha, beta and gamma radiation in various radioactive media including water, human and animal foodstuffs; natural and cultivated vegetation; soils, sediments, air filters and air cartridges.

    c. The VDH will support the VHMRT in its efforts to be fully prepared for radiological emergencies. This support will be in the form of:

        i. Technical training;

        ii. VHMRT radiological and nuclear emergency plan and procedure review and comment;

        iii. Provision of VDH radiological emergency response plans, including this annex, to the VHMRT for review and comment;

        iv. Guidance regarding radiological instruments and other equipment considered for use in radiological emergency response by the VHMRT; and

        v. Grants, as available, to assist the VHMRT for purchases of radiological emergency preparedness equipment and services.

    d. The VDH will work to help maintain the readiness of Incident Annex 9A to the State of Vermont Emergency Operations Plan (SEOP) for incidents at the Vermont Yankee and Yankee Rowe fixed nuclear facilities. The people and other resources devoted to this may be useful in response to other radiological or nuclear emergencies not covered by the Incident Annex 9A.

    e. The VDH is available to train and advise local responders so they may be more fully prepared as initial responders to an emergency that involves or may involve radioactive materials or radiation exposure, including unknown hazardous materials emergencies.

    f. The VDH is available to train and advise hospitals and other health care facilities with emergency departments so they may be more fully prepared to provide physical and mental health care to emergency workers and members of the general public following an emergency that involves or may involve radioactive materials or radiation exposure, including unknown hazardous materials emergencies.

    g. The VDH will work with Vermont Emergency Management (VEM) and the Vermont Homeland Security Unit (VHSU) to integrate radiological emergency plans of the three organizations as much as practicable.

h. The VDH will maintain radiological instruments, supplies and skills for purposes of radiological emergency response.

i. The primary purpose is for radiological incidents at Vermont Yankee. Secondarily, these instruments may be used for other routine or emergency radiological instrumentation.

ii. Instruments may be used by VDH personnel for field response activities or they may be loaned to the VHMRT for use in radiological emergencies.

iii. All personnel who use these instruments must be trained in their proper use. Just-In-Time Training can be used for this purpose.

iv. The VDH will maintain these radiological instruments and supplies in accordance with generally accepted industry standards.

v. In accordance with American National Standards Institute guidance,

1. instruments used strictly for the PRND mission or as backup supply in emergency response need not be calibrated annually.

2. They are source checked and calibrated after repair when that occurs.

2. Mitigation (Awareness and Prevention) Actions

a. The VDH will work to enhance its environmental radiological surveillance to provide early warning of unexpected and unusual radiological exposures.

b. The VDH will work to enhance its health surveillance programs to provide early warning of unexpected and unusual radiological exposures. This includes its Environmental Incident Surveillance System (EISS) and Electronic Surveillance System for the Notification of Community-based Epidemics (ESSENCE), programs. These will be useful, too, during the response phase to identify potential victims of an incident who may have left the scene and required medical care afterward.

c. The VDH will work to maintain and improve its information sharing capabilities with its partners including VEM, the VHSU, the VHMRT, VSP and the 15th CST. The aim is that each partner keep the other informed of developments. These developments include actual radiological emergencies, radiological emergency training opportunities and new or revised radiological emergency response guidance.

d. The VDH will work to enhance its public information sharing activities to better inform the public of appropriate responses to radiological emergencies.

3. Response Actions

Note: The following actions are either carried out by VDH, or the VDH should assure that the actions have been carried out adequately by others.

a. Establish incident command

i. In all circumstances, there exists the possible need to establish a unified command. Unified command is a structure that brings together the "Incident Commanders" of all major organizations involved in the incident in order to coordinate an effective response while at the same time carrying out their own jurisdictional responsibilities.

ii. On-scene, incident or unified command may be established by initial responders (fire, law enforcement, the VHMRT). Incident command or unified command established on the scene should follow the guidance of those organizations on scene.

iii. Some radiological emergencies may require a unified command among local, state and federal partners, especially large-scale incidents, trans-border incidents and criminal or terrorism incidents. Incident command or unified command established for these incidents should follow the guidance of the organizations involved.

iv. At the VDH, incident command is established at the HOC using guidance in the VDH Emergency Operations Plan. Available at the Health Department Emergency Preparedness Document Center. VDH Emergency Operations Plan.

b. If radiation is detected or suspected or the hazardous materials involved are unknown, it must be verified that on-scene responders:

i. Control the scene.

1. It is expected that the VHMRT will lead on-scene in the following activities, however, first responders may arrive without radiation instruments and be guided to:

a. Rescue all injured persons, moving them upwind and as far away from scene as possible.

b. Evacuate all non-injured persons as soon as possible, moving them upwind and as far away from the scene as possible.

2. Establish perimeters or zones

a. For radiological incidents at Vermont Yankee, follow SEOP Incident Annex 9A available at: https://vem.vermont.gov/sites/demhs/files/pdfs/plans/state/Incident%20Annex%209a_Radiological%20Emergency%20Response%20Plan_2016_08.pdf.

b. For transportation accidents, fires, non-Vermont Yankee and incidents potentially involving radioactive materials, establish an initial isolation zone of 100 meters (m) in radius for a large

spill and 300 m for a fire involving radioactive materials (according to the 2016 US Department of Transportation Emergency Response Guidebook).

c. For an explosion involving radioactive materials, e.g. a large source term nuclear power plant release or transportation incident, an RDD or a dirty bomb, establish:

    i. A hot zone of 250 m radius

    ii. A shelter-in-place zone of 500 m radius and 2000 m downwind.

    iii. RadResponder has RDD overlays useful for this.

d. For a nuclear detonation, responders should do as members of the public: Get inside and stay inside until informed by authorities it is safe. (Shelter should be in underground or far from the outside surfaces of heavy buildings.) Afterward, responders should be mindful of the:

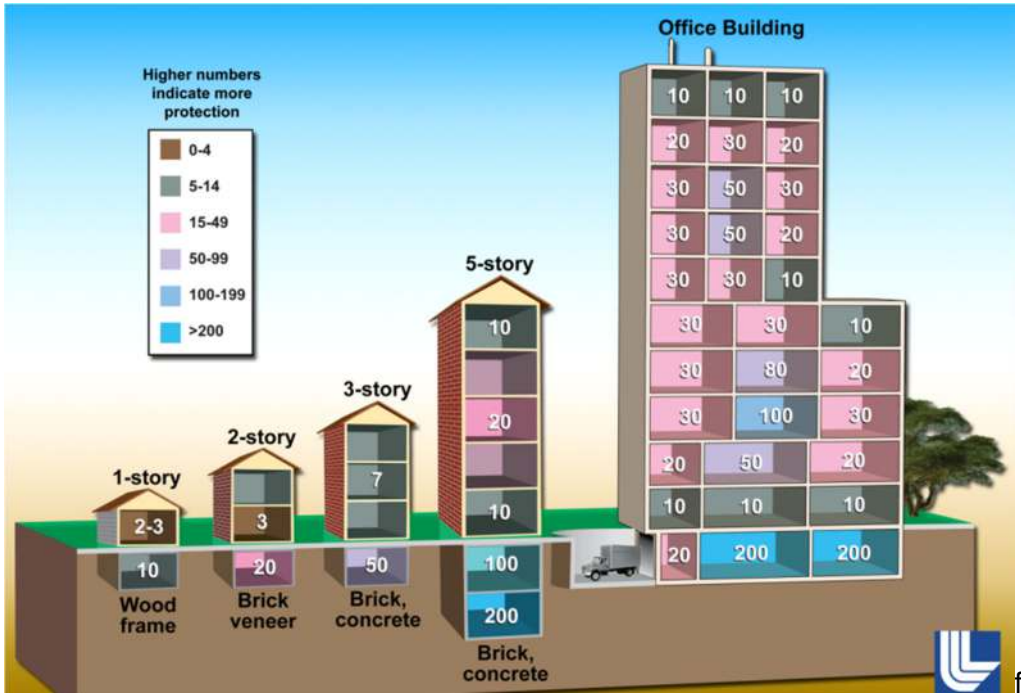
    i. Severe, moderate and light damage zones which may extend up to thousands of meters in radius.

    ii. For those authorized to work outside with radiation detectors, they should identify for incident commanders the areas with dangerous radiation levels, greater than 100 mSv/h (10 R/h).

    iii. Shelter from fallout afforded by various structures can be seen graphically in Figure 4. Transmission factors for nuclear fallout gamma radiation are seen in the table above the graphic.

FALLOUT GAMMA-RAY DOSE TRANSMISSION FACTORS FOR VARIOUS STRUCTURES

Structure	Dose transmission factor
Three feet underground	0.0002
Frame house	0.3–0.6
Basement	0.05–0.1
Multistory building (apartment type):	
Upper stories	0.01
Lower stories	0.1
Concrete blockhouse shelter:	
9-in. walls	0.007–0.09
12-in. walls	0.001–0.03
24-in. walls	0.0001–0.002
Shelter, partly above grade:	
With 2 ft earth cover	0.005–0.02
With 3 ft earth cover	0.001–0.005



factors

Figure 4. Transmission for fallout gamma radiation from Glasstone and Dolan, 1977. Shielding factors from *Planning Guidance for Response to a Nuclear Detonation*, Second edition, 2010.

e. Responders should minimize time within the control zones, limiting activities to those for lifesaving and critical property mitigation.

f. Request radiation detection teams, for example, the VHMRT, to establish zones as soon as completion of lifesaving actions allows.

3. Universal precautions should be used in any situation where the presence of radioactive contamination is suspected to help prevent the spread of contamination from surfaces or injured.

4. For outdoor explosions, empirical testing indicates that most of the airborne radioactive particles will settle in twenty minutes following an RDD.

5. Dangerous radiation zones for fallout may persist for many days after a nuclear detonation,

6. Control requires appropriate instrumentation and personal protective equipment (PPE).

    a. Where human lives may be saved through prompt action, it is unnecessary for responders to wait for instrumentation or PPE.

    b. Where prompt lifesaving actions are not the purpose, minimum instrumentation is:

        i. Gamma radiation exposure rate meter, and

        ii. A means of recording accumulating dose

            1. A personal direct reading dosimeter;

            2. A meter that also integrates total dose or

            3. A group dosimeter (a dosimeter used by one person, but representing the group working alongside that individual).

    c. Ideal instrumentation is listed here, but any working instrumentation that provides some warning of higher levels may be effective where life-threatening conditions exist:

        i. Gamma exposure rate instrument with range up to 100 mGy/h (10 Rad/h) or more (1 - 10 Gy/h);

ii. Beta-gamma contamination meter with Geiger Mueller GM pancake detector or equivalent measuring in counts per minute (CPM), DPM, Bq or other unit appropriate to contamination measurements;

iii. Alpha contamination meter with zinc sulfide detector or equivalent measuring in counts per minute (CPM) , DPM, Bq or other unit appropriate to alpha contamination measurements;

iv. Dosimeters of record for each individual, for example thermoluminescent dosimeters (TLDs) or optically stimulated luminescent dosimeters (OSLs);

v. Personal alarming digital dosimeters or exposure rate instruments with exposure and exposure rate alarms;

vi. A radioisotope identification detector (RIID or portable gamma spectrometer);

vii. A high-volume air sampler with sampling head equipped with filter holder and charcoal cartridge holder.

viii. As noted, where instrumentation options are limited, but still useful for the conditions that exist, those options should be considered useful.

d. Personal protective equipment (PPE)

i. In general, the risks to be encountered are:

1. External dose from gamma radiation fields as measured in μSv/h or Gy/h (mR/h or mRad/h).

a. Most PPE will provide no protection for this external dose.

b. Reducing time in the radiation field, maximizing distance from the source of the radiation field and using shielding, including buildings and vehicles, are the primary dose reduction principles.

2. Shrapnel embedded in persons may lead to significant external dose to the injured person and emergency medical personnel.

a. Report this finding to the VDH Radiological Sciences Program immediately.

b. Do not prevent lifesaving medical treatment, as the dose is likely easily minimized using time, distance and shielding.

c. Working at an arm's length will help with whole body dose. Using lead aprons from radiology, lead sheets of millimeter thickness, leaded glass and larger thicknesses of other metal will work to shield shrapnel in a wound.

3. Internal dose from inhaled, ingested or absorbed alpha, beta or gamma radiation emitting radioactive materials as determined by air sampling or surface contamination measurements.

    a. Respirators will provide protection, depending on the type, though minimizing time exposed and increasing distance from the scene can be of equal or greater benefit.

    b. The greatest documented protection is afforded by SCBA (10,000 OSHA protection factor), and the least is for N-95 respirators (OSHA PF of 10).

    c. Face masks and handkerchiefs may provide some protection, though it cannot be adequately documented. Both should be dry not damp. Damp facial coverings may allow more through transfer.

    d. Persons suspected of internal contamination should be subject to bioassay to calculate internal dose.

        i. The Centers for Disease Control and Prevention (CDC) is equipped to analyze human samples, especially in emergencies. They must be contacted for such arrangements.

        ii. Universities and nuclear power plants may provide whole body counting or other *in vivo* assessments.

iii. In an emergency, the VDH Laboratory and other labs may assist with urinalysis and other *in vitro* analyses.

iv. In an emergency, the VDH may set up a calibrated whole body counting capacity. It can also work with the CDC for in vitro bioassay.

e. Persons contaminated ≥ 100,000 CPM beta-gamma should be suspected of internal contamination.

f. Persons with contaminated wounds should be suspected of internal contamination.

g. People with contamination around their nose or mouth should be suspected of internal contamination.

h. Some people scanned for external contamination may continue to cause positive radiation results after decontamination. This may be indicative of internal contamination.

i. References from the NCRP that may be useful are:

i. NCRP Report No. 166, Population Monitoring and Radionuclide Decorporation Following a Radiological or Nuclear Incident (2010).

ii. Report No. 161 Volume I, Management of Persons Contaminated With Radionuclides (2008).

iii. Report No. 161 Volume II, Management of Persons Contaminated With Radionuclides: Scientific and Technical Bases (2008).

iv. Report No. 125, Deposition, Retention and Dosimetry of Inhaled Radioactive Substances (1997).

4. Skin dose from skin contamination as measured in counts per minute (CPM) with open window Geiger-Mueller (GM) radioactive contamination measuring instruments or open window beta radiation survey meter measuring in Gy/h (rad/h).

ii. Firefighters and VHMRT as first responders should have adequate protection from radioactive contamination from their turnout gear and self-contained breathing apparatus. This gear must be surveyed for radioactive contamination prior to release for unrestricted use.

1. Release or screening levels may vary depending on the incident. The ROSS Tool Kit in RadResponder provides scientifically validated screening levels for various scenarios and should be consulted.

2. For widespread areas of contamination, screening levels may be much higher than for smaller areas.

3. Where many people beyond the capacity for complete monitoring have been contaminated screening levels may be on the order of 10,000 Bq/cm^2 (600,000 dpm/cm^2) beta-gamma contamination. Alpha values should be two orders of magnitude less.

4. Where only a few people are contaminated, screening levels may be “twice background for beta-gamma contamination and zero for alpha.

iii. Other first responders may lack skin contamination protection. Laboratory gloves, face masks or respirators and Tyvek suits may be distributed to help protect the skin from contamination.

iv. Except for emergencies that involve burning radioactive materials, respiratory protection may not be indicated

for protection from airborne radioactive materials except at high concentrations.

1. Higher levels of airborne radioactivity, especially alpha emitters, may lead to significant dose from internally deposited radioactive materials.

2. Responders may lack adequate protection from internal intakes of radioactive materials, unless wearing respiratory protection.

3. Unless there is a lifesaving mission or individuals meet the United States Occupational and Safety and Health Administration (OSHA) regulations for respiratory protection, they should not be allowed exposure to airborne radioactive materials.

ii. Establish a "safe area."

1. Upwind and preferably uphill of the incident

2. Background radiation levels are preferred, but it is acceptable to use impacted areas where there are little choices, as with a nuclear detonation.

3. Generally speaking, radiation dose rates in safe areas should be no more than 20 µSv/h (2 mR/hr) radiation levels with contamination levels of less than 1,000 counts per minute (CPM) on surfaces above background.

iii. Rescue injured people.

1. Start triage and rapid treatment.

a. The US DHHS has developed the Radiation Triage, Transport and Treatment (RTR) model to deploy pre-medical, health care center and specialized health care medical services effectively following a nuclear detonation.

b. The most comprehensive reference is Medical Planning and Response Manual for a Nuclear Detonation Incident: A Practical Guide, United States Department of Health and Human Services, 2012. https://www.phe.gov/Preparedness/planning/nuclearresponsemanual/Documents/medplanresmannucdet-guide-final.pdf.

c. The model is depicted in Figure 5.

2. If life-threatening injury, treat without regard for contamination, and then transport to hospital.

3. Some patients may be expectant, likely to die from their injuries or combination of radiation dose and trauma, and scarce resources may not be best used for them when others may be saved who are not expectant unless care is not provided in time.

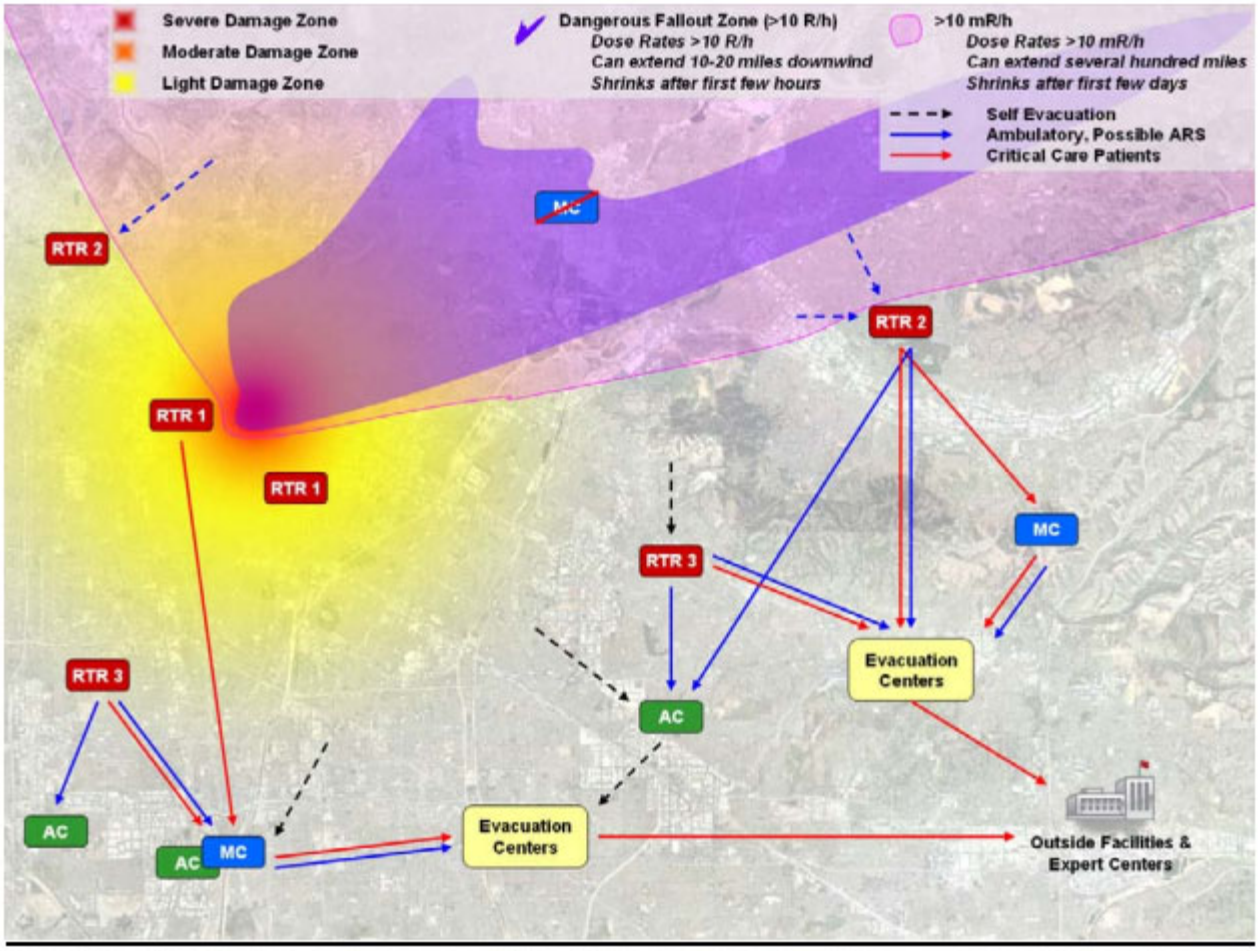


Figure 5: The DHHS RTR Model where medical care (MC) sites include hospitals, healthcare facilities and alternative care sites for those who need immediate medical care, assembly centers (AC) are collection points for displaced persons or those who do not need immediate medical attention and evacuation centers (EC) are for organized transportation. Taken from DHHS *Medical Planning and Response Manual for a Nuclear Detonation Incident: A Practical Guide,* 2012.

iv. Monitoring for contamination

1. Monitoring may consist of a single screening activity or an initial screening that leads to a more detailed screening.

    a. Initial screening may be accomplished with portal monitors or a rapid “frisk” with a detector, and detailed screening takes more time and requires close measurements.

    b. A single screening is appropriate where only a few people require monitoring. It will be a detailed screening, scanning the body slowly and within about 1 cm of the surface.

    c. There are multiple portal monitors in storage at the Dummerston VTrans office which may be allocated to the site of a radiological emergency should many people, for example, greater than 100, need screening for contamination. The detectors on the portal monitors alarm at 37 kBq (1.0 µCi).

    d. Those who alarm at or otherwise do not pass initial screening, are sent for detailed screening.

    e. The ROSS Toolkit on RadResponder provides guidance on initial screening and detailed screening values for monitoring contaminated people.

2. If not life-threatening, but contaminated (greater than 1,000 CPM over background for most incidents, but 10,000 CPM or some other appropriate value for large populations where monitoring and decontamination resources are limited):

    a. Decontaminate

        i. Removing outer clothing can eliminate the majority (80 – 90%) of contamination.

        ii. Normally, skin can be easily decontaminated with vigorous washing with liquid soap and lukewarm water.

        iii. Ideal decontamination level is not distinguishable from background however, acceptable levels are 1,000 CPM over background or more. 10,000 CPM or more above background may be used for large populations where monitoring and decontamination resources are limited.

        iv. In the worst incidents, for example a nuclear detonation, higher levels of contamination that are not life-threatening may be considered as thresholds.

v. In these catastrophic incidents, resources are likely scarce so telling people how to decontaminate themselves at home may be best.

vi. VHMRT resources, especially the 20 Decontamination Trailers interspersed across Vermont at designated fire departments, are very useful.

1. The fire department personnel where these trailers are stationed have been specifically trained to use the resources in these trailers.

2. Firefighters using these decon trailers will need just in time training to conduct screening for radioactivity in an emergency.

3. Where resources are scarce and needs are greatest, prioritization of these decon units to medical facility patients or emergency responders may be appropriate.

b. Register the person and their contact information

i. Various tools are available for this registration process, but in general it is essential to obtain identifying information and the duration of time people spent in any affected areas and any protective measures they used (shelter, shielding, medical countermeasures, etc.).

ii. For larger populations, it may be necessary to enlist VDH assistance for the large amount of documentation required to register people and their conditions. The VDH HOC Planning Section can assist with obtaining resources for this.

iii. Epidemiologists may be excellent for tracking large numbers of affected people, both the public and responders. They may have familiarity with tools like the Emergency Response Health Monitoring and Surveillance System (found at: https://www.cdc.gov/niosh/erhms/default.html) to help assess the needs of responders and the public following an emergency or Epi-Info (found at https://www.cdc.gov/epiinfo/index.html) that is useful for tracking cases and contacts that could include tracking contaminated or irradiated people.

iv. In large-scale emergencies, including where Vermont becomes the host for evacuees from larger metropolitan

areas directly affected, significant resources may be devoted to this process.

c. Release the person for medical treatment.

3. If neither life-threatening nor contaminated:

a. Register the injured person obtaining their contact information, then

b. Release them for medical treatment.

4. Note that combined trauma (burns, fractures, bleeding, etc.) with acute radiation sickness often worsens the prognosis for patients.

v. Record contact information of uninjured victims at the scene.

1. Offer monitoring and decontamination at a community reception center or issue a procedure for home contamination. The latter may be best for huge numbers of affected people.

a. A *How to Perform Decontamination at Home* sheet is available in the CRCPD Handbook for Radiological Dispersal Devices and attached as Appendix 4 to this procedure.

b. The DHS *Radiological Dispersal Device (RDD) Response Guidance* also contains a brief public announcement that is useful.

2. Send registered uninjured personnel home if home is available.

3. For people displaced from their homes, contact the Agency of Human Services, the Red Cross and/or other health and welfare services through the SEOC to provide care.

vi. Contact the VDH Radiological Sciences Program who should ensure the following is completed:

1. Measurements have been made of alpha, beta and gamma radiation levels.

a. Measuring radiation and radioactive contamination levels is important but must not delay lifesaving efforts.

i. Contamination monitoring is not a priority for a nuclear detonation.

1. Radiation dose is the primary concern in the aftermath of a nuclear detonation.

2. Radioactive fallout may emit lethal levels of radiation.

    a. Fallout is visible, the size of grains of sand or larger, non-respirable (> 1 μm in mean aerodynamic diameter) and may be removed by brushing it off. See Figure 6.

    b. Decontamination is best done by persons themselves removing contaminated clothing (decreasing contamination more than 80%), wiping with a dry cloth or a shower.

    c. Sheltering-in-place until a phased evacuation can be planned may save many lives where fallout exists outside.

        i. As mentioned, the decay of fallout follows the rule of sevens. Figure 7 depicts the theoretical radiation doses as time passes.
        ii. A planned evacuation must account for the fallout decay and identify the best path for people to take to during evacuation minimizing time in the dangerous fallout zone.

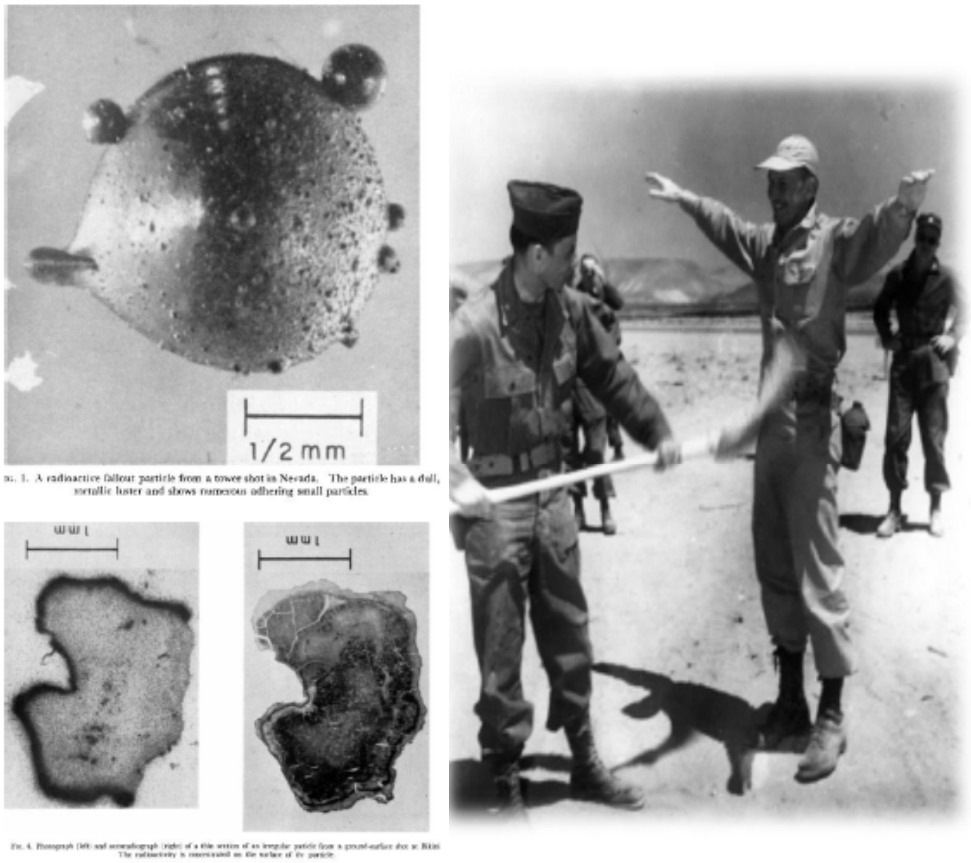


Figure 6: Magnified (top left) and radiographic images (bottom left) of fallout and US Military image of fallout decontamination at the Nevada Test Site.

RELATIVE THEORETICAL DOSE RATES FROM EARLY FALLOUT AT VARIOUS TIMES AFTER A NUCLEAR EXPLOSION

Time (hours)	Relative dose rate	Time (hours)	Relative dose rate
1	1,000	36	15
1½	610	48	10
2	400	72	6.2
3	230	100	4.0
5	130	200	1.7
6	100	400	0.69
10	63	600	0.40
15	40	800	0.31
24	23	1,000	0.24

Figure 7. Use this table to estimate when to evacuate and maps to determine the best time and direction or pathway for planned phased evacuations. From Glasstone and Dolan, 1977.

ii. Contamination is the key issue for most explosive and non-explosive radiological dispersal devices, large activity transportation accidents, nuclear power plant releases and other wide area contaminating incidents.

1. Concerns for radiation dose from contamination should be dispelled so it does not delay lifesaving or inhibit other response activities.

2. The gear many responders wear should provide sufficient protection for most radioactive contamination.

a. Alpha-emitting radioactivity and areas with very high concentrations of beta-gamma-emitting radioactivity (e.g., in the immediate area of release or detonation) may be an exception.

b. SCBA worn by firefighters and N-95 respirators worn by EMS and law enforcement should be sufficient for most airborne alpha- and beta-gamma-emitting radioisotopes.

b. Measurements must be made of direct radiation, airborne radioactivity, surface contamination and contamination on people.

i. When a lesser priority, as with a nuclear detonation, this will be subservient to higher operational assignments.

ii. With wide area contaminating incidents, radiation dose rates, particularly using the Ten-Point Monitoring Survey, may be important to ground-truthing dose projection models. See Figure 8 for Ten-Point Monitoring Survey.

iii. In some incidents, other hazards such as chemical releases, structural instability and loss of critical infrastructure may be of much higher priority to address as compared to radiological hazards.

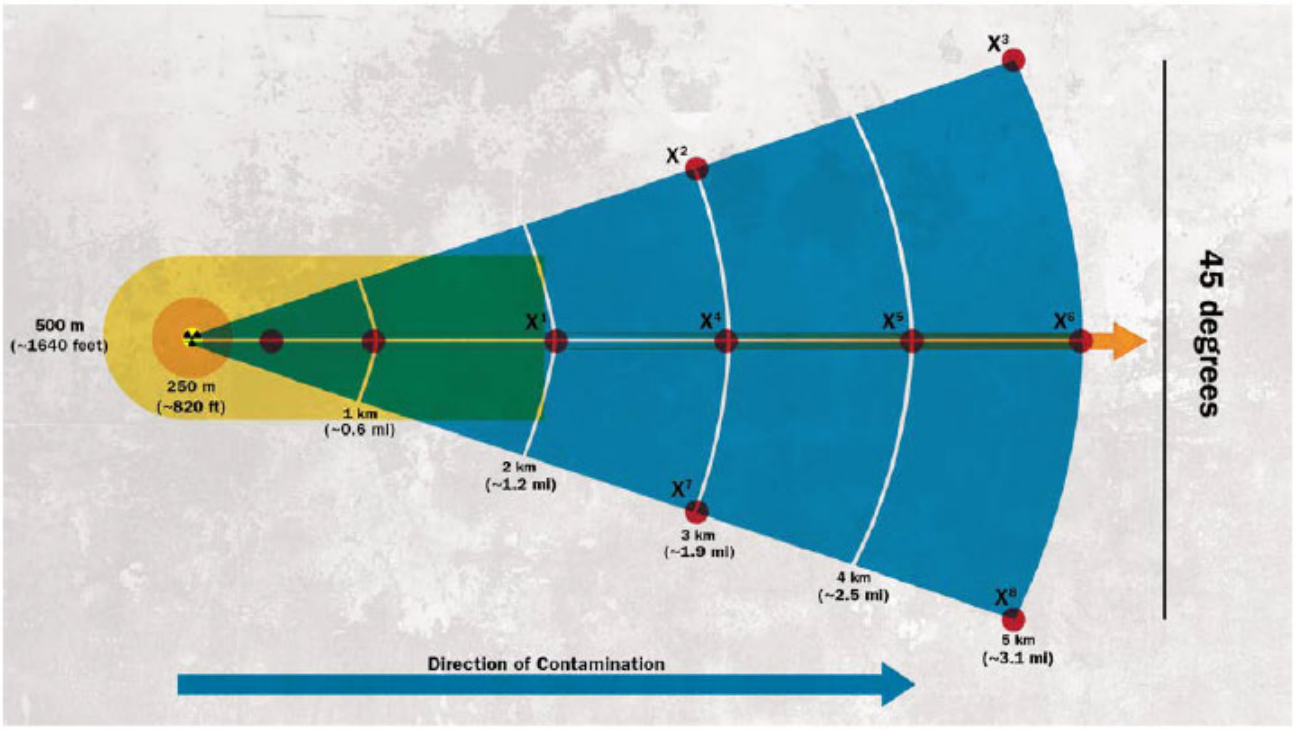


Figure 8: The Ten-Point Monitoring Plan. A description is found in the DHS *Radiological Dispersal Device (RDD) Response Guidance for the First 100 Minutes* (2017).

c. Measurements must be recorded in writing or electronically

i. Forms for RDD response are found in the DHS Radiological Dispersal Device (RDD) Guidance for the First 100 Minutes (2017).

i. NCRP Commentary 28 Implementation Guidance for Emergency Response Dosimetry (2019) provides guidance on using standard ICS forms for radiological and nuclear emergencies.

1. Use of ICS forms is highly desirable because all other responders are accustomed to using them.

2. The Assignment List (ICS 204), Activity Log (ICS 214), Operational Planning Worksheet (ICS 215), Incident Action Plan Safety Analysis (ICS215A), Resource Status Cards (ICS 219-5) and Work Analysis Matric (ICS 234) are recommended for use in NRCP Commentary 28 and may be obtained at https://www.nwcg.gov/publications/ics-forms.

ii. Forms from the CRCPD Handbook may be useful for other incidents and are attached as appendices.

3. Appendix 1 is an Initial Incident Form for documenting initial conditions after an incident is reported.

4. Appendix 2 is an Initial Site Survey form for documenting conditions at the scene.

5. Appendix 3 is a Contamination Survey Sheet for recording contamination on people.

iii. RadResponder automates radiological data collection minimizing some data recording errors and providing for a response-wide common radiological operational picture.

iv. As with all radiological data, measurements must be reported to the VDH Radiological Sciences Program for analysis and verification.

v. Where large amounts of data are collected, data management will take many people and a lot of time.

vi. A radiological data management unit may be required within the incident management system (either at the SEOC or HOC).

2. Radiation boundaries must be determined, documented in writing and periodically verified using these criteria:

   a. Dangerous Radiation Zone:

      i. ≥ 100 mSv/h (10 R/h);

      ii. Stay time of minutes to a few hours;

      iii. Primarily, restricted to life-saving activities as authorized by the Incident Commander (IC). The VDH should help prepare ICs for such decisions with training beforehand or soon after an incident emerges (just-in-time training);

      iv. Dosimetry, preferably alarming and self-reading, or survey instrument is required except where brief entry is made for lifesaving; and

      v. Personnel in this area must be surveyed for contamination prior to release unless conducting lifesaving operations.

   b. Hot zone:

      i. ≥ 100 μSv/h (10 mR/hr);

      ii. Primarily, restricted to firefighting, medical assistance, extrication and rescue as authorized by VDH;

      iii. Dosimetry, preferably self-reading and alarming, should be worn as dose rates can be well over 100 mSv/h (10 R/h); and

      iv. Personnel in this area must be surveyed for contamination prior to release unless conducting lifesaving operations.

   c. Severe damage zone (SDZ) from a nuclear detonation:

      i. Lethal levels of radiation;

      ii. Catastrophic damage to most structures with rubble 10 meters in depth or more, with immediate area transportation corridors impassable and communications infrastructure destroyed;

iii. People in this area have died or are expectant and search and rescue may lead only to additional fatalities in the search and rescue ranks;

d. Moderate damage zone (MDZ) from a nuclear detonation:

i. Dangerous radiation levels > 100 mSv/h (10 R/h) are likely so stay times must be carefully monitored with alarming dosimeters, survey meters or other means.

ii. Heavy construction buildings survive, though light structures likely did not, with overturned cars, fires and hazardous materials releases;

iii. Victims in this area may not survive unless provided lifesaving care and should be the focus for responder search and rescue;

iv. Restricted to authorized personnel only as managed by local incident or unified command with the cognizance of the VDH;

v. ROSS at incident command posts (ICPs) near MDZ

vi. Dosimetry, especially self-reading and/or alarming dosimetry or survey meters with predetermined stay-times and decision points (dose or dose rate values at which a decision to proceed or turn-back with incident command must be made) must be provided (this could include group dosimetry, where a group that remains together uses one form of dosimetry to represent the dose of each person in the group, worn;

vii. Response operations outside of lifesaving actions in this area may be managed on the basis of emergency guidelines, not necessarily occupational standards, minimizing acute radiation syndrome and

viii. Personnel in this area must be surveyed for contamination prior to release unless conducting lifesaving rescue, then they should be monitored and decontaminated as soon as possible after lifesaving rescue operations.

e. Light damage zone from a nuclear detonation:

i. Dose rates below those of the dangerous radiation zone (100 mSv/h or 10 R/h), but perhaps remaining above those for a hot zone (100 μSv/h or 10 mR/h) unless also

in the dangerous fallout zone (DFZ) which will decay with the rule of sevens (every seven-fold change in time reduces dose rates a factor of ten);

ii. Broken glass everywhere light structures seriously `damaged;

iii. Injured should be able to help themselves and each other; and

iv. Response and recovery operations outside of lifesaving actions in this area may be managed using occupational standards, including occupational dose limits.

f. Background Area or cold zone

i. Radiation levels are indistinguishable from background as determined in area unaffected by radiological emergency, for example as measured inside a response vehicle prior to arriving on-scene, but certainly < 100 μSv/h or 10 mR/hr for the worst incidents like a nuclear detonation;

ii. Unlimited stay time at background, up to 12 hours or more for essential personnel working radiological emergency where radiation levels are in excess of background;

iii. Unrestricted access if background, but restricted to authorized personnel only as managed by local incident or unified command with VDH cognizance where radiation levels are in excess of background;

iv. Dosimetry should be worn where radiation levels are in excess of background; and

v. Personnel in this area should be surveyed for contamination prior to release, if resources allow.

3. Verify or redefine radiation zone and contaminated area boundaries across time.

a. Measurements of contamination must be documented in writing and records forwarded to the Radiological Sciences Program for reporting purposes.

i. Records are useful for both dose reconstruction and for operational planning.

ii. Some information characterizing the radiological conditions must be provided to Planning and Operations for current and future response activities.

iii. Most information will be required for long-term activities like dose reconstruction (estimating doses based on time, locations and exposure rates), law enforcement investigation, legal affairs, after action review and other purposes.

b. Radioactive materials contamination may result from:

i. As fallout from a nuclear detonation, either an improvised nuclear device (IND) or weapon.

1. Fallout is characterized as early and late.

2. Early fallout decays rapidly with the Rule of Sevens (one-tenth at seven hours post-detonation, 1/100th at 49 hours, etc.)

3. Late fallout decays more slowly with half-lives in decades, centuries or more, and is similar in inventory to that of a nuclear power plant:

a. Fission products including radiocesiums and radiostrontiums and

b. Activation products created when the structural and earthen materials at ground zero were vaporized and absorbed neutrons

ii. Direct destruction of radioactive materials, including by burning in a fire or other physical or chemical reaction;

iii. Widespread scatter in an explosion as ballistic fragments of varying sizes and/or smoke;

iv. Dispersal through a mechanical ventilation or plumbing system, including as mounted on a vehicle; or

v. Transfer (cross contamination) by people, vehicles and equipment on the scene.

c. Radioactive contamination may exist as:

i. Airborne radioactive particles or gases which can be assessed using high volume air samplers including

those used by the VHMRT and stored at the Dummerston VTrans office;

ii. Surface contamination on the ground, on equipment, on people and on other surfaces, which can be assessed with direct scans or by wipe tests measured with a Geiger-Mueller pancake detector equipped survey meter, including those used by the VHMRT, stored at the Waterbury, Dummerston and VDH facilities;

iii. Concentrations of radioactivity in human and animal foodstuffs which can be sampled using kits with the VHMRT trucks, at the Waterbury storage facility and the VDH Environmental Health Lab and assessed with radiochemical analysis at the VDH Laboratory.

d. Ideally, an area where no or very low levels of contamination exists would be chosen for the location of a command post, for staging areas and for access/egress control points.

i. In a wide area contaminating incident, these kinds of operations may also be allowed in areas with low levels of contamination (e.g., levels of up to a few times background with background being established in an area where the radiological incident has had no impact).

ii. For a nuclear detonation, ICPs, staging areas and access/egress control points may be established with less restriction because dose rates maybe high for extensive areas and for extended periods of time.'

iii. The VDH Radiological Sciences Program must help Operations and Planning identify suitable areas for the establishment of the response support capabilities.

e. For fires, nuclear power plant releases, and other emergencies that create a plume of airborne radioactive materials:

i. The path must be physically tracked to determine the actual extent of contamination as deposition or, in the case of a nuclear detonation, fallout. The VHMRT is skilled at doing this, and they may use this plan and its appendices to do so.

ii. The VDH Radiological Assessment Science Team may be able to model the plume with computer software, providing the VHMRT better estimates of the plume path based upon weather conditions.

iii. Samples from the environment and from human and animal food stuffs may be required to prevent ingestion of radioactive materials, and to point to needed restriction of some areas and embargo of some food stuffs or water sources.

iv. Sampling procedures are in Appendix 8.

1. SP-1 is generic to all sampling activities

2. SP-2 through SP-17 are for different media to be sampled.

3. These procedures may be adapted for other similar media.

v. Air samples should be taken of the immediate and adjacent areas of the plume path using a high-volume air sampler equipped with a glass fiber filter for capturing particulates and a TEDA impregnated or silver zeolite-impregnated charcoal gas cartridge.

1. TEDA cartridges are best for noble gases like radioxenons and radiokryptons

2. Silver zeolite cartridges are best for radioiodines.

3. Air samples may be measured in the field for estimates of airborne contamination, and some value may be obtained by comparing equal measurements in affected and unaffected areas. A field sample measurement form is found as Appendix 2, but RadResponder is the best tool to document radiological data collected.

4. The Radiological Sciences Program must be consulted in the taking and measurements of airborne radioactivity samples.

vi. All samples must be separated and put in resealable plastic bags labeled with the date, time and location of the sample, and the name of the person taking the sample. This information may be entered in RadResponder and on the Environmental Sample Identification Tag (Appendix 7). The Sample ID number should be written directly on the bag.

vii. Quantitative measurements, including gamma spectroscopy, at the VDH Laboratory must be matched to the samples and compared to derived concentration

levels for decisions on disposition of the products sampled.

f. Radioactive contamination may exist on any surface. It is measured either by directly scanning the surface or by scanning a wipe test (a filter paper or similar) that has been used to collect removable surface contamination.

   i. Whether scanning a surface directly or a wipe test, the unit of measure in the field is the CPM (counts per minute) net over background.

      1. Final measurements are recorded in disintegrations per minute (DPM), Bq or microcuries (µCi).

      2. The VDH Lab analyses will provide measurements of wipe tests in Bq or µCi.

      3. Responders in the field can make a crude estimation of DPM from their measurement results by dividing the CPM by 0.1, which assumes an efficiency of 10 percent.

   ii. When reporting wipe tests, the CPM should be related to a surface area size of 100 square centimeters (cm^2), an area of about 4 inches by 4 inches.

   iii. Wipe tests must be placed separately in resealable plastic bags and labeled. Labeling can be done by writing the location, date and time of the sample, as well as the name of the person taking the wipe test.

   iv. An instrument useful in measuring contamination is an open window Geiger-Mueller (GM) detector measuring the surface at a distance of about 1 centimeter (cm) away. It is preferable the GM detector be a pancake GM detector.

   v. Scanning for loose surface contamination cannot be done where background radiation levels may mask it. Where exposure rates are elevated, a wipe test can be taken and the wipe can be measured in a low background radiation area.

g. For many incidents, especially those that contaminate the environment, or food and water supplies, the Agency of Agriculture, Food and Markets (AAFM) and/or the Agency for Natural Resources (ANR) must be consulted and may be helpful identifying sampling sites and methods.

h. There are numerous tools that make environmental sampling more effective.

i. Visual Sampling Plan from the Pacific Northwest National Laboratories is helpful for planning the number of samples and sample sites needed to meet specific statistical requirements.

ii. Argonne National Laboratory's ResRad suite of software can make surveillance and assessment of the natural and human-built environment more effective. ResRad RDD is specific to that scenario.

4. Establish dose guidelines and dosimetry.

a. Generally, occupational radiation worker dosimetry practices are sought in an emergency.

i. For relatively small incidents where only the VDH and/or the VHMRT are engaged, occupational radiation worker standards may be met easily.

ii. For large-scale incidents especially where doses may be high for many people in many places, these standards may be impractical or even inappropriate because of the number of responders involved or where implementation might delay lifesaving actions.

b. For large-scale incidents, incident commanders must be allowed to assess the totality of the circumstances for lifesaving actions.

i. This may mean that dosimetry and other personal protection requirements are relaxed.

ii. As soon as possible after lifesaving actions are accomplished, a goal will be to manage radiation work to occupational regulatory standards.

c. In all cases, however, doses to radiation will be managed to amounts that are as low as reasonably achievable (ALARA).

d. Recommendations for managing dose to responders:

i. Alarming dosimetry should be worn in any area where radiation levels are in excess of 100 mSv/h (10 R/h) and some form of dosimeter should be worn where radiation levels are in excess 100 μSv/h (10 mR/h). The Canberra instruments the VHMRT uses and the

RadEyes the VDH use can be set to alarm for dose and dose rates.

ii. One direct reading device may be shared by several people in extreme cases but should be assigned to each specific individual by name and dosimeter identification number. This is called group dosimetry.

iii. Should it be possible to apply occupational standards without adversely impacting lifesaving missions, the ideal is a combination of a dosimeter of official record, a direct reading dosimeter and an alarming dosimeter, especially one that alarms for both cumulative exposure and for instantaneous exposure rate.

iv. The VDH Limits for Emergency Workers in these scenarios are those of Title 10 of the Code of Federal Regulations, Part 20 (10 CFR 20).

v. The Emergency Worker Decision Points (formerly turn-back) for these occupationally based controls are 10 mSv (1 Rem) whole body dose and 1 mSv/h (100 mR/h) exposure rate.

vi. Where occupational standards cannot be applied for example after a nuclear detonation, the goal is to work to EPA standards as seen in Table 1. These Decision Points are:

1. For non-lifesaving critical activities - 100 mSv (10 rem) whole body dose and 100 mSv/h (10 R/h).

2. For lifesaving activities - 0.5 Gy (50 rad) whole body dose and 0.5 Gy/h (50 Rad/h) dose rate.

vii. The incident commander may decide that higher decision points are acceptable based on the totality of circumstances in lifesaving situations.

e. Dose recommendations for the public:

i. For limited scope emergencies, the 10 CFR 20 dose limits for the public should be the goal.

ii. For other incidents, public dose is managed using EPA PAG Manual guidance where possible. This is provided in Table 3.

iii. For catastrophic incidents, public doses should be maintained ALARA.

1. Lessons learned from Fukushima and other radiological and non-radiological emergencies include that some protective actions may result in worse consequences than those likely due to radiation dose alone.

2. Evacuation and relocation, for example, may result in serious injuries, exacerbated illness or death and these risks may be far greater than the risks of radiation exposure.

3. Similarly, some stakeholders may not think it wise for large numbers of people to be relocated, and for large amounts of land and numerous societal benefits in their communities to be abandoned where the only benefit may be lower radiation exposure and a decreased risk of possible chronic effects like cancer many years in the future.

4. While acute doses make some protective actions simple to choose extreme measures of protection, stakeholder engagement should be fostered before decisions are made to evacuate or relocate areas for low levels of radiation exposure.

Table 3 Public Dose Guidance from EPA PAG Manual

Table 1-1. Summary Table for PAGs, Guidelines, and Planning Guidance for Radiological Incidents[a]

Phase	Protective Action Recommendation	PAG, Guideline, or Planning Guidance
Early Phase	Sheltering-in-place or evacuation of the public[b]	**PAG**: 1 to 5 rem (10 to 50 mSv) projected dose over four days[c]
	Supplementary administration of prophylactic drugs – KI[d]	**PAG**: 5 rem (50 mSv) projected child thyroid dose[e] from exposure to radioactive iodine
	Limit emergency worker exposure (total dose incurred over entire response)	**Guideline**: 5 rem (50 mSv)/year (or greater under exceptional circumstances)[f]
Intermediate Phase	Relocation of the public	**PAG**: ≥ 2 rem (20 mSv) projected dose[e] in the first year 0.5 rem (5 mSv)/year projected dose in the second and subsequent years
	Apply simple dose reduction techniques	**Guideline**: < 2 rem (20 mSv) projected dose[e] in the first year
	Food interdiction[g]	**PAG**: 0.5 rem (5 mSv)/year projected whole body dose, or 5 rem (50 mSv)/year to any individual organ or tissue, whichever is limiting
	Drinking water	**PAG**: 100 mrem (1 mSv or 0.1 rem) projected dose, for one year, to the most sensitive populations (e.g., infants, children, pregnant women and nursing women); 500 mrem (5 mSv or 0.5 rem) projected dose, for one year, to the general population
	Limit emergency worker exposure (total dose incurred over entire response)	**Guideline**: 5 rem (50 mSv)/year
	Reentry	**Guideline**: Operational Guidelines[h] (stay times and concentrations) for specific reentry activities (see Section 4.5)
Late Phase	Cleanup[i]	**Planning Guidance**: Brief description of planning process (see Section 5.1)
	Waste Disposal	**Planning Guidance**: Brief description of planning process (see Section 5.2)

[a] This guidance does not address or impact site cleanups occurring under other statutory authorities such as the United States Environmental Protection Agency's (EPA) Superfund program, the Nuclear Regulatory Commission's (NRC) decommissioning program, or other federal or state cleanup programs.

[b] Should begin at 1 rem (10 mSv); take whichever action (or combination of actions) that results in the lowest exposure for the majority of the population. Sheltering may begin at lower levels if advantageous.

[c] Projected dose is the sum of the effective dose from external radiation exposure (e.g., groundshine and plume submersion) and the committed effective dose from inhaled radioactive material.

Note: Footnotes continued on next page

Table 1-1. Summary Table for PAGs, Guidelines, and Planning Guidance for Radiological Incidents (continued)

[d] Provides thyroid protection from radioactive iodines only. See the complete 2001 FDA guidance, "Potassium Iodide as a Thyroid Blocking Agent in Radiation Emergencies" (FDA 2001). Further information is also available in "KI in Radiation Emergencies – Questions and Answers" (FDA 2002), and "Frequently Asked Questions on Potassium Iodide (KI)." For information on radiological prophylactics and treatment other than KI, refer to http://www.fda.gov/Drugs/EmergencyPreparedness/BioterrorismandDrugPreparedness/ucm063807.htm, https://www.emergency.cdc.gov/radiation, and www.orau.gov/reacts.

[e] Thyroid dose. See Section 1.4.2. The one-year old age group is expected to receive the largest dose to the thyroid from exposure to radioactive iodine. Therefore, it is recommended that the one-year old age group is considered when considering the administration of prophylactic KI.

[f] When radiation control options are not available, or, due to the magnitude of the incident, are not sufficient, doses to emergency workers above 5 rem (50 mSv) may be unavoidable and are generally approved by competent authority. For further discussion see Chapter 3, Section 3.1.2. Each emergency worker should be fully informed of the risks of exposure they may experience and trained, to the extent feasible, on actions to be taken. Each emergency worker should make an informed decision as to how much radiation risk they are willing to accept to save lives.

[g] For more information on food and animal feeds guidance, the complete FDA guidance (FDA 1998) may be found at http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM094513.pdf.

[h] For extensive technical and practical implementation information please see "Preliminary Report on Operational Guidelines Developed for Use in Emergency Preparedness and Response to a Radiological Dispersal Device Incident" (DOE 2009).

[i] This cleanup process does not rely on and does not affect any authority, including the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. 9601 et seq. and the National Contingency Plan (NCP), 40 CFR Part 300. This document expresses no view as to the availability of legal authority to implement this process in any particular situation.

5. Identify radioisotopes.

    a. In all radiological emergencies, this is important.

    b. In some circumstances, for example transportation accidents, documentation may exist to identify the radioactive materials involved in a radiological emergency. Consult this documentation, including vehicle placards and manifests.

    c. In other cases, the identity of the radioactive materials involved may be unknown, and a radioisotope identifier, like a portable gamma spectrometer, may be used to identify the material.

        i. The VDH has such radioisotope identification detectors (RIIDs),.

        ii. VHMRT and the Vermont State Police Bomb Squad have RIIDs of their own that may be useful.

    d. Care must be taken in identifying isotopes with portable gamma spectrometers, as it usually takes a significant amount of activity to obtain reliable results.

    e. RIIDs do not allow determination of radioactive materials that do not emit gamma radiation. For pure alpha or pure beta radiation emitting radioactive materials, the VDH Radiological Sciences Program may be able to help on-scene responders narrow down the possibilities.

6. Assist in monitoring and decontamination of victims.

    a. The resources and procedures employed formerly used for the Vermont Yankee Reception Center may be useful as a model in this endeavor.

    b. Monitoring may be accomplished using hand-held GM detector equipped survey meters or using portal monitors. Portal monitors are particularly useful for large populations. Monitoring of large populations may be aided with the guidance form the CDC found at: http://emergency.cdc.gov/radiation/.

    c. Monitoring and decontamination of victims must be documented in writing, with the records sent to the VDH Radiological Sciences Program for retention and medical follow-up as necessary. Appendix 3 provides a useful form for documenting contamination on people.

    d. Many victims may suffer from the emotions of the incident, and the Behavioral Health Disaster Response Plan should be used to define actions in response to these needs. This plan is maintained by the Department of Mental Health within the Agency of Human Services.

    e. Decontamination guidelines:

        i. Removing outer clothing can eliminate the majority (80 – 90%) of contamination.

        ii. Normally, skin can be easily decontaminated with vigorous washing with liquid soap and lukewarm water.

        iii. Ideal decontamination level is not distinguishable from background, however, acceptable levels are 1,000 CPM over background. 10,000 CPM may be used for large populations where monitoring and decontamination resources are limited.

        iv. VHMRT resources, especially the 20 Decontamination Trailers interspersed across Vermont at designated fire departments, are very useful. The fire department personnel where these trailers are stationed have been specifically trained to use the resources in these trailers.

    f. The ROSS Toolkit in CBRNResponder has excellent guidance to be considered.

    g. Register person and their contact information. Epi-Info, referenced earlier, may be useful for this purpose.

h. Release person for medical treatment, if necessary.

7. Monitor and decontaminate first responders.

   a. The resources and procedures employed for the former Vermont Yankee Emergency Worker Radiological Monitoring and Decontamination may be useful in this endeavor.

      i. Other guidance for Community Reception Centers is provided by the CDC at https://www.cdc.gov/nceh/radiation/emergencies/populationmonitoring.htm.

      ii. Extensive helpful information is provided, but significant planning not yet undertaken in Vermont is required to meet the minimum recommendations.

      iii. It will take a significant amount of time to set up facilities and gather resources and this reinforces sheltering in place rather than prompt evacuation for radiological and nuclear emergencies.

   b. Monitoring may be accomplished using hand-held GM detector equipped survey meters or using portal monitors. Portal monitors are particularly useful for large numbers of emergency responders.

   c. Monitoring and decontamination of emergency responders must be documented in writing, with the records sent to the VDH Radiological Sciences Program for retention and medical follow-up as necessary.

   d. Some emergency responders may suffer from the emotions of the incident, and the Behavioral Health Disaster Response Plan from the Department of Mental Health should be used to define actions in response to these needs.

   e. Decontamination guidelines:

      i. Removing outer clothing can eliminate the majority (80 – 90%) of contamination.

      ii. Normally, skin can be easily decontaminated with vigorous washing with liquid soap and lukewarm water.

      iii. Ideal decontamination level is not distinguishable from background, however, acceptable levels are 1,000 CPM over background. 10,000 CPM may be used for large

populations where monitoring and decontamination resources are limited.

iv. VHMRT resources, especially the 20 Decontamination Trailers interspersed across Vermont at designated fire departments, are very useful. The fire department personnel where these trailers are stationed have been specifically trained to use the resources in these trailers.

f. Register person and their contact information

g. Release person for medical treatment, if necessary.

8. Provide technical support to medical personnel.

a. Medical facilities may receive victims of the radiological emergency. Though they may have prepared themselves for this and other kinds of similar emergencies, guidance and/or consultation services that the VDH can share with them:

i. Radiation Emergency Assistance/Training Site (REAC/TS) at: http://orise.orau.gov/reacts/.

ii. CDC at http://emergency.cdc.gov/radiation/clinicians.asp.

iii. Armed Forces Radiobiology Research Institute at: https://www.usuhs.edu/afrri.

iv. Department of Health and Human Services at: https://www.remm.nlm.gov/index.html..

v. Hospital Radiation Safety Officers, radiation oncologists or nuclear medicine physicians may provide valuable guidance at specific medical facilities.

b. Some patients may present with symptoms some significant time after a radiological exposure, VDH health surveillance systems may help identify these individuals for further assistance such as recording of exposure facts, dose reconstruction and medical follow-up.

c. General guidelines:

i. Cases may not present with obvious signs and symptoms of radiation exposure other than physical contamination, but they may present with symptoms of trauma from other physical incidents such as fire or explosion. Acute radiation syndrome need not manifest

in prompt signs or symptoms which may arise hours, days or weeks after exposure.

ii. Assess and treat life-threatening injuries immediately – do not delay for contamination monitoring and/or decontamination.

iii. Routine emergency care should be performed during extrication procedures even if in a contaminated area.

iv. For patients without life-threatening injuries, decontaminate if not contraindicated and treat.

v. Retain contaminated belongings in labeled plastic bags for later dose reconstruction and as possible evidence in law enforcement activities.

vi. Exposure to radiation fields without contamination requires no decontamination – treat for radiation exposure alone.

vii. Expose contaminated wounds and flush gently with ample lukewarm water, then treat.

viii. Internal contamination should be evaluated for persons with contamination in or around the mouth or nose, contaminated wounds and for those contaminated in excess of 100,000 CPM.

ix. Many patients may present with behavioral symptoms, and these may dominate the medical triage activities. Mental health professionals must be incorporated into the overall medical response at health care facilities, and the Department of Mental Health should be consulted for assistance.

9. Provide support to the Public Information Officer.

    a. Effective information management is critical, particularly for large-scale, newsworthy or terrorist radiological emergencies.

    b. The VDH Crisis and Emergency Risk Communication Plan provides extensive guidance to help manage information to and from the public.

    c. While press releases and other information provided to the public is important, providing telephone hotlines for receiving public information may be equally important to help with public health concerns, dispel rumors and collect previously unknown

factual information important to the overall emergency response.

4. Recovery Actions

    a. Recovery occurs after:

        i. Injured victims have been provided medical care;

        ii. Contaminated and uncontaminated uninjured victims have been provided care;

        iii. Radiation and contamination zones have been verified;

        iv. Evidence has been collected;

        v. All response actions and conditions have been documented; and

        vi. Restricted zones and embargoed foodstuffs have been isolated.

    b. Recovery actions include:

        i. Medical follow-up for victims and emergency responders.

            1. Ideally, contact information was obtained for each person to reestablish contact for medical follow-up.

            2. Interviews may be used to obtain dose reconstruction information as well as to conduct medical follow-up.

        ii. Remediation of contamination in restricted areas.

            1. Some areas may be remediated easily and soon after.

            2. Some areas may be remediated later after weathering and radioactive decay.

            3. The VDH Radiological Sciences Program will work with experts to establish appropriate remediation methods.

        iii. Isolation or disposal of radioactive materials, including incident debris, response wastes.

            1. Licensed vendors will be needed for transportation, brokerage and disposal of wastes.

            2. Areas to be isolated will require special considerations to ensure control of access which may be developed in consultation with state agencies and other experts.

iv. Processing of emergency worker dosimetry for external doses of record.

1. Dosimeters of record must be processed by the appropriate vendor for official external dose assignment.

2. For those without dosimeters of record, dose reconstruction is described below.

v. Determination of emergency worker and public internal doses.

1. Bioassay, via urinalysis, fecalanalysis or *in vivo* radioactivity analysis (whole body counting, for example) are the best methods.

a. Universities and nuclear power plants my assist with *in vivo* assessments.

b. The VDH Laboratory and other labs may assist with urinalysis and other *in vitro* assessments.

2. Internal dose reconstruction by the VDH Radiological Sciences Program may also be done using established expert guidance.

a. Dose reconstruction must follow acceptable practices.

b. Calculated doses may be documented as doses of record given thoroughness in accordance with acceptable practices.

c. Records from the incident will be critical to this dose reconstruction.

vi. Reconstruction of emergency worker and public external doses where dosimetry was unavailable.

1. Dose reconstruction must follow acceptable practices.

2. Calculated doses may be documented as doses of record given thoroughness in accordance with acceptable practices.

3. Records from the incident will be critical to this dose reconstruction.

vii. Creation of a registry of exposed individuals to facilitate monitoring emergency responders and the general public for long-term health effects, followed by periodic evaluation of registry data for cases of radiogenic effects and to establish trends.

VI. RESPONSIBILITIES

1. The following table identifies the lead and support organizations for the preparedness, mitigation, response and recovery actions for a radiological emergency.

2. The table may be useful as a checklist for essential actions that are more thoroughly described in part V of this annex.

3. The actions and responsibilities listed in this table are separate from those that might arise for a radiological emergency at Vermont Yankee Nuclear Power Station (VYNPS).

4. The actions and responsibilities for radiological emergencies at VYNPS are described in plans and procedures of Vermont Emergency Management's Radiological Emergency Response Plan.

Preparedness Actions	Lead Agency	Support Agency or Agencies
Radiological and nuclear Emergency Annex annual review	Vermont department of Health (VDH) Radiological Sciences Program	Department of Public Safety (DPS), Agency of Natural Resources (ANR), Agency of Agriculture, Food and Markets (VAAFM)
Radiological and nuclear Emergency Annex revision for after action review and corrective action plans	VDH Radiological Sciences Program	
Radiological emergency response training of Vermont Hazardous Materials Team (VHMRT) Technicians	VDH Radiological Sciences Program	DPS VHMRT
Maintenance of VDH Laboratory radiological instrumentation and procedures	VDH Laboratory	VDH Radiological Sciences Program
Maintenance of VDH radiological instrumentation and procedures	VDH Radiological Sciences Program	
Maintenance of VHMRT radiological instrumentation and procedures	VHMRT	VDH Radiological Sciences Program
Maintenance of Vermont Yankee Radiological Emergency Response Plan, procedures, instrumentation and procedures	DPS Vermont Emergency Management	VDH Radiological Sciences Program
Training of state and local first responders in radiological emergency response	VDH Radiological Sciences Program	
Training of health care facilities in radiological emergency response	VDH Radiological Sciences Program	
Integration of VDH radiological and nuclear emergency plans into State of Vermont Emergency Operations Plan (EOP) and Health Department EOP	DPS VEM, VDH Division of Emergency Preparedness Response and Injury Prevention (DEPRIP)	VDH Radiological Sciences Program

Mitigation Actions	Lead Agency	Support Agency or Agencies
Maintenance of VDH radiological environmental surveillance and procedures	VDH Radiological Sciences Program	
Maintenance of VDH radiological health surveillance and procedures, including the Preventive Radiological Nuclear Detection (PRND) Program	VDH Health Surveillance Division	VDH Radiological Sciences Program
Government information sharing regarding radiological emergency preparedness	VDH Radiological Sciences Program	DPS VEM, Vermont Homeland Security Unit, Vermont Intelligence Center
Public information sharing regarding radiological emergency preparedness	VDH Radiological Sciences Program and Communication Office	DPS VEM, Vermont Homeland Security Unit

Response Actions	Lead Agency	Support Agency or Agencies
Establish incident command on-scene	First responders	VDH Radiological Sciences Program, VEM, Vermont State Police (VSP)
Contact Department of Energy (DOE) Consequence Management Home Team (CMHT) for Aerial Monitoring System (AMS) and Interagency Modeling Atmospheric Assessment Center (IMAAC) for plume and dose models	Radiological Sciences Program	Vermont Emergency Management
Establish incident command at VDH Health Operations Center (HOC)	VDH DEPRIP and Radiological Sciences Program	Remaining elements of HOC from VDH and Agency of Human Services (AHS)
When appropriate provide support to the State Emergency Operations Center (SEOC) when activated	VDH Radiological Sciences Program	VEM
Dispatch the VHMRT to the scene for radiological technical response	VEM	VDH Radiological Sciences Program, local first responders, VSP
Control the radiological incident scene	First responders	VHMRT, VDH Radiological Sciences Program
Rescue injured persons	Local EMS	VHMRT
Evacuate non-injured	Local first responders	VHMRT
Monitor scene for radiation and radioactive contamination	VHMRT	VDH Radiological Sciences Program
Establish a safe area for command, staging, radiological monitoring, decontamination, injury triage	VHMRT	First responders, VDH Radiological Program
Decontaminate people with non-life-threatening injuries or no injuries	VHMRT	VDH Radiological Sciences Program
Record contact information of all personnel involved, public and emergency responders	VHMRT	VDH Radiological Sciences Program
Measure radiation levels	VHMRT	VDH Radiological Sciences Program
Establish radiation area boundaries, including severe, moderate and light damage zones and dangerous radiation/fallout zone	VHMRT	VDH Radiological Sciences Program
Define contamination area boundaries, including dangerous fallout zone	VHMRT	VDH Radiological Sciences Program

Sample for airborne radioactivity	VHMRT	VDH Radiological Sciences Program
Identify radioisotopes in field	VHMRT	VDH Radiological Sciences Program
Project doses from radiation and radioactivity	VDH Radiological Sciences Program	VDH Dose Assessors
Sample environment for radioactive contamination	VDH Radiological Sciences Program	Radiological Sampling Team (VHMRT with possible supplementation by VDH Public Health Inspectors and staff from the Agency for Natural Resources and Agency of Agriculture and Food and Markets)
Analyze samples for radioactivity in field (screening)	VHMRT	VDH Radiological Sciences Program
Quantitatively analyze samples for radioactivity by concentration	VDH Laboratory	VDH Radiological Sciences Program
Monitor dose of emergency responders, compare to dose guidelines	VHMRT	VDH Radiological Sciences Program
Provide behavioral health assistance to public	Vermont Department of Mental Health	VDH Radiological Sciences Program
Provide behavioral health assistance to emergency workers	Vermont Department of Mental Health	VDH Radiological Sciences Program
Monitor and decontaminate emergency responders	VHMRT	VDH Radiological Sciences Program
Provide technical support to medical personnel	VDH Radiological Sciences Program	VHMRT
Provide technical support to public information officer	VDH Radiological Sciences Program	VEM

Recovery Actions	Lead Agency	Support Agency or Agencies
Medical follow-up of public and emergency workers	VDH Epidemiology	VDH Radiological Sciences Program, VHMRT (for contact information)
Remediation of contaminated areas	VDH Radiological Sciences Program for technical guidance, Agency of Natural Resources (ANR) Department of Environmental Conservation (DEC) Division of Waste Management and Prevention for actions.	Remediation vendors, VHMRT for health and safety, State and Federal agencies
Isolation and disposal of radioactive materials	VDH Radiological Sciences Program for technical guidance, ANR DEC Division of Waste Management and Prevention for actions.	Radioactive waste transportation and disposal vendors, VHMRT for health and safety, State and Federal agencies
Processing emergency worker dosimetry of record	VDH Radiological Sciences Program	Dosimetry vendors
Determination of emergency worker external and internal dose	VDH Radiological Sciences Program	Bioassay vendors as needed
Reconstruction of emergency worker and public internal and external dose	VDH Radiological Sciences Program	Dose reconstruction vendors as needed

VII. AUTHORITIES

1. Vermont Statutes Annotated, Title 18, Chapter 32: Ionizing and Nonionizing Radiation Control.

2. Vermont Statutes Annotated, Title 20, Chapter 1, §33: Hazmat Teams, Team Chiefs; Creation.

3. Vermont Statutes Annotated, Title 18, Chapter 31: New England Compact on Radiological Health Protection.

VIII. FEDERAL INTERFACE

1. For minor radiological incidents, most preparedness, mitigation, response and recovery actions may be accomplished with in-state resources, though seeking guidance from other resources.

2. For larger radiological incidents, Federal authorities including the Federal Emergency Management Agency, the Environmental Protection Agency, the Department of Energy and the Centers for Disease Control and Prevention will be involved.

    a. These agencies may provide valuable resources to the incident response.

    b. Unified command may be established to coordinate State and Federal responses and to integrate resources into the overall incident action plan.

3. For criminal radiological incidents, federal law enforcement agencies including the Federal Bureau of Investigations and Department of Homeland Security will be involved.

    a. These agencies may provide valuable resources to the incident response.

    b. Unified command may be established to coordinate State and Federal responses and to integrate resources into the overall incident action plan.

Appendix 1

Initial Incident Form

Forward completed form to the VDH Radiological Sciences Program. Complete as much as you can.

Location and Time of Incident:	**Contact Person:**
□ Residential □ Commercial □ Industrial □ Other (specify)	On-site Incident Commander: Person completing this form: Cell phone/pager number:
Emergency Responders On Scene:	**Affected Members of the Public:**
□ Police □ Fire □ Vermont HAZMAT □ VDH Radiological Health □ Other Radiation Experts	□ Estimated number of victims _____ □ Estimated number of injured victims _____
Conventional Hazards:	**Radiological Hazards:**
□ Fire □ Chemicals □ Explosives □ Other (specify)	□ Significant Radiation Dose □ Release to the Environment □ Inhalation Hazard □ Contaminated Areas □ Other (specify)
Meteorology:	**Is Access Controlled?**
At time of incident: Wind Speed_____ and Direction_____ **Current:** Wind Speed _____ and Direction_____	□ No □ Yes How?

Nuclide Identification (if possible)

Instrument Type _____ Model _____ Serial # _____
Nuclides:

Person(s) Interviewed:	**Phone Number**	**Affiliation**

Actions to prevent or reduce exposure of responders:

Actions to measure exposure of responders (dosimetry):

Appendix 2

Initial Site Survey

Instrument Type _____ Model _____ Serial # _____
Check Source Measurement _____ Background Measurement _____

Maximum measurement and distance from incident site for:

Exposure rate (@ waist level): _____ R/hr _____ yds

Contamination: _____ cpm with pancake GM _____ yds

Dose rate at ICP: _____ mR/hr

Contamination at ICP: _____ cpm with pancake GM (ICP: Incident Command Post)

Diagram of the Source and Surrounding Area

Include location of radiation area boundaries, relevant radiation readings, landmarks and distances

Comments:

Signature of person completing this form
Date: **Time:**

Appendix 3

CONTAMINATION SURVEY SHEET

First Name: _____ Middle Initial: _____ Last Name:_____

Date of Birth: _____ Phone:_____

Address_____

Date/Time: _____ Driver's License #_____

Location at time of incident:_____

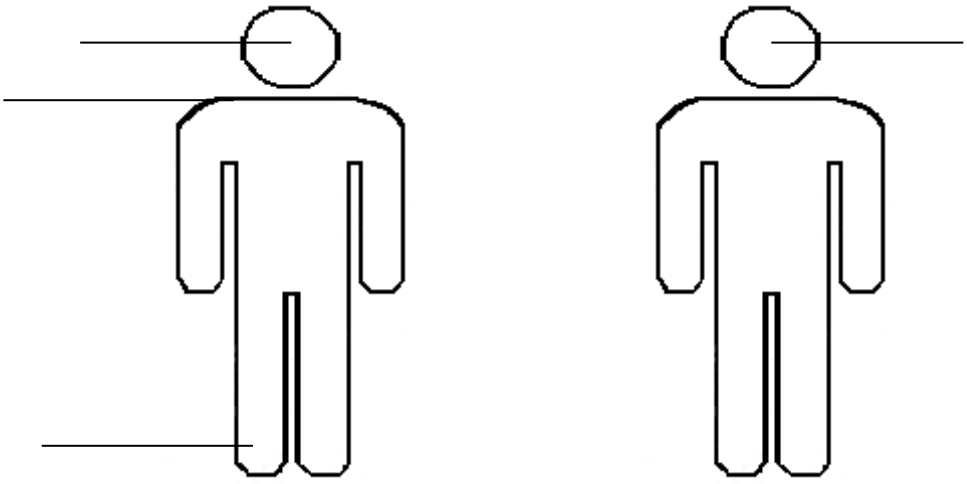
_____

Parent or Guardian (if child):_____

Mark contamination locations and survey reading on the diagrams below.

Circle if readings are in cpm mR/hr µR/hr

FRONT **BACK**



Survey results <1,000 cpm_____ >1,000 cpm_____ >10,000 cpm_____
Comments:_____

_____

_____

Monitored by: _____
Person sent to decontamination area: _____Yes _____No
Clothing and valuable bag number: _____ Valuables returned: _____Yes _____No
Nasal area reading of 100,000 cpm or 0.5 mR/h: ___Yes _____No
If yes, refer to medical facility
Person sent to medical facility: _____Yes ____No

Appendix 4
HOW TO PERFORM DECONTAMINATION AT HOME

You may have been exposed to low levels of radioactive particles. The particles may have settled on your hair, skin and clothing as dust. You are not in immediate danger from these small radioactive particles, however you do need to go home or to another designated area to decontaminate. Removal of outer clothing should reduce your contamination by up to 90%. In order to help protect your health and safety as well as others, please follow these directions.

Because radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not immediately know if you have been exposed to radioactive materials. You can take the following steps to limit your contamination:

- Get out of the immediate area quickly. Go directly home, inside the nearest safe building, or to an area to which you are directed by law enforcement or health officials. *Do not go to a hospital unless you have a medical condition that requires treatment***.**

- If radioactive material is on your clothes, removing them will reduce the external contamination and decrease the risk of internal contamination. Prompt removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the article off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the article over the head. Removal of clothes should be done in a garage or outside storage area if available, where the ground can be washed with a hose. If an outside area is not available, the removal of clothing should take place in a room where the floor can be easily cleaned, such as the tub or shower areas. Dry dusters are good for decontaminating smooth floor surfaces). Clothing should be rolled up with the contaminated side “in” to minimize cross contamination.

- If possible, place the clothing in a plastic bag (double bagging is best to reduce the chances of a rupture), and leave it in an out-of the-way area, such as the corner of a room or garage. Keep people away from it to reduce their exposure to radiation. You may be asked to bring this bag for follow-up readings or for disposal at a later time.

- Keep cuts and abrasions covered when handling contaminated items to avoid getting radioactive material in the wound.

- Shower and wash all of the exposed parts of your body and hair using lots of soap and lukewarm water to remove contamination. Simple washing will remove most of the radioactive particles. Do not use abrasive cleaners, or scrub too hard. Do not use hair conditioners. This process is called decontamination.

- If you are going to a monitoring location, change clothes and shower *before* being monitored.

Contact the Vermont Department of Health Radiological Sciences Program for additional guidance.

Appendix 5

HOW TO PERFORM A RADIATION SURVEY FOR CONTAMINATION—INSTRUCTIONS FOR WORKERS

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly.

Make sure that the instrument has batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a check source to verify the instrument is operating properly.

Screening Survey

- *If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.*

  If only performing a screening survey, it is acceptable to hold the survey meter probe about 1-2 inches away from the body (instead of half an inch), and move it twice as fast as the normal 1-2 inches/second. (If the probe is moved too quickly, its detection capability may be reduced.) Check with the Vermont Department of Health Radiological Sciences Program to determine the extent of contamination survey required.

- Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

- If feasible, perform a complete, whole body contamination survey and record the findings on the Contamination Survey Sheet. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a half-inch away from the surface to be surveyed, slowly (1-2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination).
2. Front of the neck and shoulders.
3. Down one arm (pausing at elbow), turn arm over.
4. Backside of hands, turn over (pause at palms for about five seconds).
5. Up the other arm (pausing at elbow), turn arm over.
6. Shoe tops and inside ankle area.
7. Shoe bottoms (pause at sole and heel).

- As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

- Holding the probe too far away from the surface (should be about 1-2 inches away for a screening survey or about 1/2 inch or less for a detailed survey).

- Moving the probe too fast (should be about 2-4 inches per second for a screening survey or about 1-2 inches per second for a detailed survey.)

- Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use probe. Otherwise, check with radiation control personnel.

Appendix 6

INSTRUCTIONS TO THE PUBLIC WAITING FOR DECONTAMINATION AT THE SCENE OF THE INCIDENT

You may have been exposed to radioactive particles. The particles from the explosion may have settled as dust on your clothes or body. In order to protect your health, you may be asked to go to a decontamination center. Do not panic, your health is not in immediate danger. You should follow these directions to prepare for decontamination:

1. Go to the designated area.
2. Do not touch your face or put anything into your mouth.
3. Enter the screening area and stand for a screening (survey) of yourself with clothing, and provide the workers with necessary personal information.
4. After you are screened, you will be directed to leave if minimal or no contamination is present. If contamination is found, you will be directed to the wash area, or you may be sent home with instructions how to clean up (decontaminate) there.
5. If you are directed to enter the wash area, you will be segregated with individuals of the same gender. To the extent possible, families will be kept together through the decontamination process. Prepare to remove your outer garments behind a privacy curtain. If radioactive material is on your clothes, removing them will reduce the external contamination and decrease the risk of internal contamination. Prompt removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the article off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the article over the head.
6. You will be provided with plastic bags. Place all of your clothing in one bag and your valuables in another plastic bag and seal them. You may be asked to double bag your belongings to minimize the potential for bag rupture. You will be instructed on how to handle these items at a later time when we know more about the hazards of the material used.
7. Pass through the wash area.
8. When you reach the end of the wash station you will be given clothing to put on, and then be directed to the final staging area.

Appendix 7

VERMONT DEPARTMENT OF HEALTH LABORATORY
RADIOLOGICAL EMERGENCY SAMPLE FORM

PRIORITY [ ] YES [ ] NO
As determined by Rad Health Advisor

General Information

Sample Type: [ ]Air [ ]Food [ ]Feed [ ]Milk [ ]Ground Deposition [ ]Soil [ ]Vegetation [ ]Water

Sample ID: place label here

Collected By: _____

Collected Date/Time: _____ Field Sample ID: _____
(Team-MMDDYY-0100M)

Field Team: _____

Physical Location: _____ Location: _____
(GPS Coordinates)

Comment: _____

Quantity

Volume: _____ Weight: _____

Additional Sample Type Information

Air — Air Pump: _____ Flow Type: _____
Media: _____ Flow Unit: _____
Start Time: _____ Start Volume: _____
End Time: _____ End Volume: _____
Ground — Depth: _____ Surface Area: _____
Milk — Milk Feed: _____ Milking Date: _____
Milk Type: _____ Herd Population: _____
Preservative: _____
Swipe — Surface Area: _____
Water — Is Potable: _____ Preservative: _____

Contamination Check

Timestamp: _____ Is Clean: _____
(Clean wipe is < 100 CPM above background)
Completed By: _____ Wipe CPM above background: _____

Sample Double Bagged: [ ] Yes [ ] NO

Contact Dose Rate

Rate: _____ Comment: _____

Analysis Requested

[ ] Gross Alpha [ ] Gamma Spectroscopy [ ] Other _____
[ ] Gross Beta [ ] Tritium

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Custody Transfer:

	Name (print):	Signature:	Date/Time:
Received By:			
Relinquished By:			
Received By:			
Relinquished By:			
Received By:			
Relinquished By:			
Received By:			
Relinquished By:			
Received By:			
Relinquished By:			
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Appendix 8

Sampling Procedures SP-1 through SP-17

SP-1 SAMPLE COLLECTION GUIDELINES

Minimizing the cross-contamination of people, equipment, and samples is a high priority. To limit, wear gloves and foot coverings when collecting the sample. Change frequently. Used gloves and booties should be placed in a radioactive waste bag. Tools (clippers, funnels, trowels.) should be cleaned by washing or wiping thoroughly between samples.

Sample identification tag should be placed in a 1-gallon plastic bag and attached to exterior of outer bag.

A chain of custody form should be submitted with samples.

A sample Collection Log should be maintained by the team.

Sample ID Numbers are in the format: Team Number-6 Digit Date-24 Hour Time.

Team # - MMDDYY – HHMM Example: 01-102506-0830

<u>Standard Sample Collection</u>

Equipment & Supplies:

- RadEye-B20 ER
- Pail for sanitizing & bottle brush
- Waterproof marker/pens
- Sample container (cubitainer/plastic bags)
- Heavy duty plastic bag
- Funnel (for liquids)
- Smear/wipes
- Sample forms (ID Tag, Chain of Custody, Collection Log)
- Decontamination supplies

Label sample containers with:

- ID#
- Sample type (as specific as possible)
- Location
- Date and time of sampling
- If outdoors, take and record a ground and waist high (1 meter) exposure rate reading (µR/hr or mR/hr)

For samples collected directly into plastic bags:

- Only clean plastic bags should be used.

- Wearing clean gloves, roll the bag open
- Place sample in bag
- With clean gloves (original sampler or another team member), close the bag without touching the sample.
- Air should be removed from bag. Make sure to squeeze air away from other personnel.
- Seal bag tightly
- Double bag (at a minimum!) taking care not to contaminate the second bag
- Scan exterior of bag at about 1 to 3 inches per second and at about ½ inch from the surface to get exposure rate (µR/hr, mR/hr).
- Record reading on sample ID tag
- Elevated readings (above background) should be reported to sample team director before transport.
- Record exposure rate from bag scan
- Wipe test the outer bag. Verify less than 100 cpm over background on the wipe.
- If wipe measurement is more than 100 cpm over background, place in another bag.
- Repeat wipe test and rebagging until measurement is less than 100 cpm over background.

For samples collected directly into cubitainers, or other containers:

- Only new/clean containers should be used.
- Rinse cubitainers with a small amount of clean water to remove any manufacturing contaminants.
- Use a clean funnel when pouring into a cubitainer to prevent spills.
- Wearing clean gloves, open container and collect sample.
- With clean gloves (original sampler or another team member), close and secure the container without touching the sample.
- Containers should be handled to prevent exterior contamination.
- Place in clean bag
- Seal bag tightly
- Scan exterior of bag to get highest exposure rate (µR/hr, mR/hr).
- Record reading on sample ID tag
- Elevated readings (above background) should be reported to sample team director before transport.
- Wipe test the outer bag. Verify less than 100 cpm over background on the wipe.
- If wipe measurement is more than 100 cpm over background, place in another bag.
- Repeat wipe test and rebagging until measurement is less than 100 cpm over background.

Completely fill out ID tag, Chain of Custody, and Collection Log.

SP-2 CHEESE AND OTHER DAIRY FOOD SAMPLING PROCEDURES

Purpose: to determine if these products are safe for human consumption. Radioactive iodine, cesium, and strontium are readily transferred to humans through dairy products.

Appropriate test(s) unless otherwise specified: gamma spectroscopy, include iodine-131

Site Selection: Multiple sample locations (e.g. raw milk, aged cheese etc.) inside a production facility may be required. Consultation with state and federal Agency of Agriculture staff and assessment scientists will be done to determine number and types of samples, depending on type of processing or manufacturing facility.

Precautions: All required food sanitation procedures must be followed when collecting raw or unfinished/unpackaged products. Assistance must be requested from trained dairy personnel.

Specific sample selection considerations:

Sample type	minimum age (approx.)
Cultured cheeses	7 days
Cottage cheeses	2 days
Butter	2 days
Ice cream	2 days
Yogurt/sour cream	2 days
Infant formula	7 days
Powdered milk or whey	2 days

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (cubitainer/plastic bags)
Heavy duty plastic bag
Funnel (for liquids)
Smear/wipes
Pail for sanitizing & bottle brush (if needed)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size: 1 gallon (4 liters). A decision on appropriate sampling container will be determined by discretion of team leader.

Follow standard collection procedure.

SP-3 DRINKING WATER SAMPLING PROCEDURES (potable taps)

Purpose: To determine if water is safe for human and animal consumption by identifying location, type, and amount of radionuclides in drinking water.

Appropriate test(s) unless otherwise specified: gross alpha, gross beta, gamma spectroscopy, tritium

Site Selection considerations: Water samples should be taken from potable drinking water taps (faucets), when possible. Source water should be noted: dug well, spring, surface water.

Note whether the supply is a municipal, private, and/or agricultural water supply.

Precautions: Water should be sampled as used. If sample is taken at a public water supply a raw sample should also be taken.

Specific sample selection considerations: Note source and any site-specific conditions, for example, if a capped well, the well tag ID# or if it is a public/private and/or agricultural water source.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (cubitainer)
Heavy duty plastic bag
Funnel
Bucket for collection
Smear/wipes
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

____ 1. If a well, purge water

____ A. If the depth of the well is known, run water 1 minute for every 40 feet in depth

____ B. If unknown, purge for 10 minutes. *To limit total sampling time, you may want to start water running, then collect other requested sample media from the site.*

____ 2. Collect water in bucket.
____ 3. Fill pre-rinsed cubitainer with the water in the bucket to 1 inch below the opening (approximately 1 gallon).
____ 4. Seal
____ 5. Carefully dry the exterior of any water--take care to not contaminate the exterior.

Sample size: 1 gallon (4 liters) cubitainer, or equivalent.

SP-4 EGG SAMPLING PROCEDURE

Purpose: to determine if eggs are safe for human consumption.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Collect directly at the farm or store based on the incident sampling plan created by the Assessment Scientists. Note whether the eggs are fresh or pre-packaged as from a grocery store.

Precautions: All required food/farm sanitation procedures must be followed when collecting raw or unpackaged products. Direction from trained personnel is required.

Note whether eggs were taken from chicken coop, taken from package and whether the eggs had been washed.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (cartons/cardboard box)
Heavy duty plastic bag
Smear/wipes
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size: seven (7) dozen eggs in egg cartons or cardboard box with cushioning

SP-5 FRUIT AND VEGETABLE SAMPLING PROCEDURE

Purpose: to determine if locally grown produce is safe for human consumption.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Sites may be gardens, farms, roadside stands, orchards, retail or processing locations. Sites will be selected by assessment scientists and agricultural personnel.

Precautions: Collections at agricultural facilities should be done with a team member knowledgeable in crops.

Specific sample selection considerations: If a specific fruit or vegetable is not specified by the assessment scientists (for example, they request “leafy greens” or “berries”), teams may use the below table or the knowledge of the grower/seller to select the sample.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1- gallon plastic bags)
Heavy duty plastic bag
Smear/wipes
Shears for cutting
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size: One gallon (4 liters), a minimum of 0.5 gallons (2 liters) is needed.

leafy vegetables	lettuce chard cabbage Brussel sprouts	cauliflower spinach broccoli asparagus kale
bulb & root crops	onions radishes kohlrabi carrots	turnip potatoes beets parsnips
Legumes	green beans pole beans lima beans	field beans peas peanuts
Grains	sweet corn	wheat

fruits & berries	tomatoes peppers apples cucumbers pumpkins	grapes blueberries raspberries strawberries blackberries squash

SP-6 HAY / SILAGE SAMPLING PROCEDURE

Purpose: To determine if harvested hay/silage is safe for use as animal feed.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Sites may be farms and hay dealers and will be selected by assessment scientists and agricultural personnel.

Precautions: Sampling at agricultural facilities should be done with a team member knowledgeable in animal feeds.

Specific sample selection considerations: Alfalfa, clover, and corn silage are samples of preference. Samples must be from products harvested after the beginning of the contaminating event, or from areas which were unprotected during the event (e.g., face of feed bunk or unwrapped round bales). Care should be taken to prevent hay stems from puncturing sample bag.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1- gallon plastic bags)
Heavy duty plastic bag
Smear/wipes
Shears for cutting
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size: one gallon (4 liter) plastic bag

SP-7 MAPLE AND HONEY SAMPLING PROCEDURE

Purpose: to determine if maple syrup/sap and honey are safe for human consumption.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Maple locations should be selected only if maple processing occurred after the radiological release. Note the size of the sugar bush at the maple farm.

Precautions: Only trained apiary personnel will collect honey from the hive. No team member that has a bee allergy will go to honey collection site.

Specific sample selection considerations: Note any flow information from farmers. If products have already been packaged--but were produced or collected after event—those packaged may be used in place of raw samples.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1- gallon plastic bags or cubitainer, depending on packaging)
Heavy duty plastic bag
Smear/wipes
Pail for sanitizing & bottle brush (if needed)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size for maple syrup/sap: ½ to 1 gallon
Sample size for honey: 1 filled shallow-framed section or ½ to 1 gallon pre-packaged container

SP-8 MEAT, MEAT PRODUCTS, AND POULTRY SAMPLING PROCEDURE

Purpose: To determine if meat, meat products, and poultry are safe for human consumption. The primary radionuclides of concern are radiocesiums in muscle tissue. These and other radionuclides may be detected in liver and kidney.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Slaughter and packing houses, meat markets, and retail stores which obtain animal products from impacted areas. Fish and Wildlife Department will determine the time and place for wild game sampling. Note the name of the Fish & Wildlife official that caught the animal in the paperwork.

Precautions: All biological and sanitation control procedures will be followed at facility. Agency with regulatory authority (USDA, FDA, VAAFM, US/VT-F&W*) over facility, other than retail shop, will provide guidance to team members.

Specific sample selection considerations: If any specific licenses or permits are needed, these will be obtained prior to collection. If wild game is to be sampled, Fish & Wildlife will provide personnel to locate, slaughter and dress. If possible, animals that are sampled will be retained (frozen) until after testing is complete. Thyroid tissues from all animals will be collected/batched separately. Beef and poultry sample source (collection site, type of body part) should be identified as specifically as possible.

All equipment must be sanitized for both radiological and biological contamination. Regulatory authority will provide guidance.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1- gallon plastic bags)
Heavy duty plastic bag
Smear/wipes
Shears for cutting
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size: 4 pounds of the specific type of meat requested from the assessment scientists, cut into 2 inch cubes, when possible. Do not cut the thyroid tissue. Samples should be stored in cooled location during transport.

* USDA – U.S. Dept. of Agriculture, FDA – U.S. Food and Drug Administration, VAAFM – Vermont Agency of Agriculture, Food and Markets, US/VT-F&W – U.S. Fish & Wildlife or Vermont Fish & Wildlife.

SP-9 MILK SAMPLING PROCEDURE

Purpose: To determine if milk is safe for human consumption by identifying location, type, and amount of radionuclides in milk. Radioiodines, cesiums, and strontiums concentrate in milk.

Appropriate test(s) unless otherwise specified: gamma spectroscopy including iodine-131 (I-131)

Site Selection:

- Raw milk samples should be collected from the dairy farm bulk tank, the milk tank truck at its terminal, receiving station and/or processing plant, or from the processing plant's raw storage tanks.
- Pasteurized milk samples should be collected from dairy processing plants. Efforts to identify source of farms in batch should be made and noted.
- Consultation with state and federal Agency of Agriculture staff and assessment scientists will be done to determine number and sample locations.

Precautions: Milk samples will be taken only by team members specifically trained to do so and/or farm personnel. The Agency of Agriculture, Food and Markets will identify state trained samplers.

Specific sample selection considerations: Goats concentrate more radioactive materials and may generally have higher concentrations of radioactive materials. Grazing cattle and goats may also have higher concentrations than barn-fed animals. When possible, source of feed and dairy should be noted.

<u>Equipment & Supplies:</u>

RadEye-B20 ER
Waterproof marker/pens
Sample container (cubitainer)
Heavy duty plastic bag
Funnel
Bucket for collection
Smear/wipes
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Raw Milk
A farm employee or trained agriculture staff should take sample. Gloves should be provided to the sampler. The cubitainer should be pre-rinsed and pre-labeled. Agitate the milk for 5 minutes if tank is less than 2500 gallons. If greater in volume, agitate for 10 minutes and collect the sample.

Additional information about the sample should be noted on sample Collection Log:
- Name of sampler
- Number of milkings in the tank (or volume of tank)
- Age of the milk in the tank.
- Origin of milk in tanks

____ 1. Wearing safety glasses, place at least one (1) cup of household bleach in 12-quart (12 liter) plastic pail and fill with warm water. Submerge sampling pitcher in sanitizing solution.

____ 2. After five minutes of tank agitations (ten minutes if tank is greater than 2500 gallons), sample is collected through the top opening in tank with well drained sanitized pitcher. Tank trucks are sampled through manhole on top. Some large farm tanks and plant storage tanks may have to be sampled through sampling cock or tank outlet valve. Open valve slowly.

____ 3. Transfer one gallon (4 liters) of milk to the sample container. Try to avoid foaming during transfer.

Pasteurized Milk

Additional information about the sample should be noted on sample Collection Log:

- Name of sampler
- Age of the milk
- Origin of milk

____ 1. Collect packaged product, enough to fill four-liter sample container from packaging machine if running or from the plant storage cooler

____ 2. Fill sample container directly from packaged milk product, avoid foaming.

SP-10 SEDIMENT SAMPLING PROCEDURE

Purpose: to determine if long-lived radionuclides have deposited in water bodies and if they may be concentrated in food chains.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Lakes, ponds, and slow-moving streams and rivers.

Precautions: Sampling from water bodies can be dangerous. Specialized equipment and precautions may be needed.

Specific sample selection considerations: Outlets of streams and rivers may accumulate more sediment.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1- gallon plastic bags or cubitainer, depending on packaging)
Heavy duty plastic bag
Smear/wipes
Pail for sanitizing & bottle brush (if needed)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Do not enter rivers or streams with currents that could sweep you down stream. Use safety line and buddy system. Disturb mud being sampled as little as possible.

____ 1. Using plastic bucket, gently collect from top one to two inches of sediment disturbing this area as little as possible. Try to sample in six inches to one foot of water upstream from where you are standing. After sample is collected in bucket, let stand and then pour off excess water. Avoid gravel, sand, and large sticks.

____ 2. Using funnel, transfer sediment to 4-liter plastic jug. Fill 3/4 full, cap it, and check for leaks.

SP-11 SNOW SAMPLING PROCEDURE

Purpose: to determine if radionuclides have deposited with or on snow.

Appropriate test(s) unless otherwise specified: gamma spectroscopy, gross alpha, gross beta, and tritium

Site Selection considerations: as requested.

Precautions: Walking in and sampling snow may be slippery. Take care to not get snow on instruments.

Specific sample selection considerations: Open fields, away from sheltered areas (tree canopies etc.). If possible, take only snow that fell during or post-incident. (*e.g.,* down to crusted snow level)

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (cubitainer)
Heavy duty plastic bag
Smear/wipes
Large pail (5 gallon or similar)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies
Measuring tape
Small shovel

____ 1. Mark off an area 1 foot by 1 foot by 2 inches deep. This is approximately 1 gallon of snow. If snow fall is recent or it is snowing at the time, the team director should provide more specific guidance.

____ 2. Pack the bucket with snow. Avoid any obvious debris. Record surface area and depth sampled. If additional sample is required, sample to a greater depth and record change in depth. Seal pail with lid.

____ 3. Where possible, melt snow as follows:

- ____ A. Fill sink with hot water.
- ____ B. Submerge pail containing snow in hot water.
- ____ C. Transfer melted snow to one gallon (four liter) flexible plastic jug or multiple one liter plastic jars

Note: When impossible or impractical time-wise to melt snow, snow will be sent to the laboratory in the five-gallon pail.

SP-12 GROUND DEPOSITION SAMPLING PROCEDURE

Purpose: to determine extent of contamination by identifying location, type, and amount of radionuclides on soil.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: as requested.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Heavy duty plastic bag
Smear/wipes
Large pail (5 gallon or similar)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies
Measuring tape
Small shovel

Specific sample selection considerations: Open fields, away from sheltered areas (tree canopies etc.). Limited amount of rocks and debris. If vegetation is on soil, it should be cut away.

____ 1. Using a tape measure, mark off a one square foot area free of stones and debris.

____ 2. Using the entrenching tool, remove the soil outlined to a depth of approximately one inch. This will be equal to 0.08 cubic feet.

SP-13 SURFACE WATER SAMPLING PROCEDURE

Purpose: To determine if a potable water supply source has been contaminated. This sampling is important in the early phase of an event.

Appropriate test(s) unless otherwise specified gross alpha, gross beta, gamma spectroscopy, tritium

Site Selection considerations:

- Choose an area that is no sheltered by trees or high brush.
- If possible, consider where intake of water supply is located. Assessment may want samples at a certain proximity to intake, and this should be specified in mission description provided to the sampling team directors.
- Avoid areas of debris, high turbidity and high sediment.
- If a river sample, mid-stream is preferred.
- Sample should come from water closest to the surface.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (cubitainers)
Heavy duty plastic bag
Smear/wipes
Large pail (5 gallon or similar)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Precautions: Sampling at surface water can be dangerous. Take extra care and caution to protect team members. Collecting from a bridge or deck may be the safest option. Buckets should not touch bottom and sediment should not be disturbed or included in sample. If sample is taken from a boat, be sure to wear personal flotation devices.

SAMPLE COLLECTION

____ 1. Collect sample following standard procedure described in SP-1 with below steps:

____ A. Note source (*e.g.* river, stream, lake reservoir) and any site-specific conditions (distance from intake, sample location identifier)

____ B. Collect water in bucket.

____ C. Fill pre-rinsed cubitainer with the water in the bucket to 1 inch below the opening (approximately 1 gallon).

____ D. Seal

____ E. Carefully dry the exterior of any water--take care to not contaminate the exterior.

SP-14 VEGETATION/GRASS SAMPLING PROCEDURE

Purpose: to give information on location, type, and extent of radionuclide deposition (not uptake) including if this pathway presents a problem for livestock ingestion.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: farm fields that are not yet cut, or cut only after the incident started

Special precautions: Poison Ivy, wild parsnip

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (multi-gallon plastic bag)
Heavy duty plastic bag
Smear/wipes
Large pail (5 gallon or similar)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies
Measuring tape
Shears for cutting

Specific sample selection considerations: Open, uniform fields, away from sheltered areas (tree canopies etc.). with limited amount of debris. Mechanically cut fields are preferred. Since early phase is concerned with deposition, only collect above ground portions of plants.

Sample size: Multi -gallon plastic bag (packed), 1 kilogram weight is needed

____ 1. Using a tape measure, mark off an area one meter by one meter (39.5 inches by 39.5 inches). Remove sticks and other debris from the area.

____ 2. With grass shears or knife, cut the outlined vegetation 2.3 cm (approximately one inch) from the ground. If vegetation is sparse, sample a larger area and report area size sample on Environmental Sample Identification Tag.

SP-15 WILD FOODS

Purpose: to determine if local wild food is safe for human consumption and to define area of deposition.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Sites will depend on requested food and time of year.

Precautions: Poison Ivy, wild parsnip

Specific sample selection considerations: Note approximate collection area. Fungi are found in moist wooded areas. Dandelions and berries in open, sunny fields. Fiddleheads, along riverbanks.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1-gallon plastic bags)
Heavy duty plastic bag
Smear/wipes
Shears for cutting
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Sample size: One gallon (4 liters), a minimum of 0.5 gallons (2 liters) is needed.

SP-16 FISH SAMPLING PROCEDURE

Purpose: To determine if commercial or wild fish are safe for human consumption. Fish can be an important source of radionuclides, especially strontium-90.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: Water bodies that may have been impacted by deposition or fish hatcheries. Fish & Wildlife personnel will assist with site selection and collection.

Special precautions: All biological sanitation procedures will be followed. Fish & Wildlife will provide guidance.

Specific sample selection considerations: If any specific licenses or permits are needed, these will be obtained prior to collection. The fish should have been caught post-incident. Note species and mass of fish, when possible.

All equipment must be sanitized for both radiological and biological contamination. Regulatory authority will provide guidance.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Sample container (1-gallon plastic bags)
Heavy duty plastic bag
Smear/wipes
Shears for cutting
Pail for sanitizing & bottle brush
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies

Collect at least four (4) pounds of specified species following the guidance provided in your mission briefing. Hydroid and adjacent tissue present a special case (obtain whatever amount you can).

SP-17 SOIL SAMPLING PROCEDURE

Purpose: to determine extent of contamination by identifying location, type, and amount of radionuclides on soil.

Appropriate test(s) unless otherwise specified: gamma spectroscopy

Site Selection considerations: as requested.

Equipment & Supplies:

RadEye-B20 ER
Waterproof marker/pens
Heavy duty plastic bag
Smear/wipes
Large pail (5 gallon or similar)
Sample forms (ID Tag, Chain of Custody, Collection Log)
Decontamination supplies
Measuring tape
Small shovel

Specific sample selection considerations: Open fields, away from sheltered areas (tree canopies etc.). Limited amount of rocks and debris. If vegetation is on soil, it should be cut away.

____ 1. Using a tape measure, mark off a one square foot area free of stones and debris.

____ 2. Using the entrenching tool, remove the soil outlined to a depth of approximately one inch.

Appendix 9

RadEye B20-ER Operation

In general, the left arrow opens the menu screen and de/selects menu items, the right confirms and exits, and the up and down arrows toggle through choices. If no buttons are pressed for several seconds the measurement display screen will reappear.

- Putt on the H*10 dose filter for dose rate, closed window readings. (Removing the H*10 filter may automatically change the instrument to count rate mode and the units to cpm.)

- Turn on the RadEye by pressing and holding the ON button (also the down arrow). The instrument should alarm, vibrate and flash.

- Check battery indicator icon. If the battery indicator is at half or less, replace batteries (rubber cover will need to be removed).

- Check to be sure that heart icon is pulsing. This indicates that the meter is working.

- Turn on **LED, Sound and Vibrator** alarm indicators, if not activated:
    - Press menu key (left arrow)
    - Toggle through menu (up/down arrows)
    - Select “Alarm indication” (left arrow)
    - **LED, Sound, Vibrator** should all be selected (left arrow selects/deselects)
    - Exit (right arrow, or wait several seconds)

- **Clear dose** (this should be done at the beginning of each shift for the team):
    - Press menu key (left arrow)
    - Toggle through menu (up/down arrows)
    - Select “**Clear dose**” (left arrow)
    - Confirm (left arrow twice)
    - Exit (right arrow, or wait several seconds)

- Select desired **Measuring Unit (Sv/h or rem/h):**
    - Press menu key (left arrow)
    - Toggle through menu (up/down arrows)
    - Select “**Measuring Unit**” (left arrow)
    - Select **R/h** from menu (left arrow)
    - Exit (right arrow, or wait several seconds)

- If removal or H*10 dose filter does not do so automatically, you can manually change to **Ratemeter** mode:
    - Press menu key (left arrow)
    - Toggle through menu (up/down arrows)
    - Select Operation Mode
    - Select “**Ratemeter**” (left arrow)
    - Exit (right arrow, or wait several seconds)

Hold RadEye over gamma check source (cesium-137 or comparable, the source is usually attached to document box). Verify response is in check source range.

Appendix 10

Air Sampling/Site Characterization Data Form

Team & Instrument Data (Shaded values are needed for tracking team director to calculate radioiodine concentration)

Team ID/ Leader: _____ Date: _____

RadEye B20-ER Serial #_____ Cal. date (last)_____

RadEye K-factor $\left(\frac{dpm}{cpm}\right)$ (on instrument case) _____

Air Sample Pump Serial #_____ Cal. date (last) _____

Background Data

Time required for sample (280 Liters) _____minutes

Blank_____cpm (1st) _____cpm (2nd) Average _____cpm

Sample Site Data and Characterization

Sample Location (address or description)_____

GPS Coordinates (decimal degrees) __ __ . __ __ __ __ __ __ / – __ __ . __ __ __ __ __

Take exposure rate measurements *before* air sampling (in plume if > 2X background & continuous). **Circle** units.

Waist Height Open_____ $\frac{uR}{hr}$ ⋮ $\frac{mR}{hr}$ ⋮ $\frac{R}{hr}$ Closed_____ $\frac{uR}{hr}$ ⋮ $\frac{mR}{hr}$ ⋮ $\frac{R}{hr}$

Ground Height Open_____ $\frac{uR}{hr}$ ⋮ $\frac{mR}{hr}$ ⋮ $\frac{R}{hr}$ Closed_____ $\frac{uR}{hr}$ ⋮ $\frac{mR}{hr}$ ⋮ $\frac{R}{hr}$

Notify tracking team director if >100 $\frac{mR}{hr}$ *is obtained for a closed window reading.*

Collect sample

Air sampler time on_____Air sampler time off_____Number of minutes _____

Take exposure rate measurement *after* air sampling at waist height. **Circle** units.

Waist Height: Open_____ $\frac{uR}{hr}$ ⋮ $\frac{mR}{hr}$ Closed_____ $\frac{uR}{hr}$ ⋮ $\frac{mR}{hr}$

Background Sample Data Drive to clean area outside plume, check dosimetry, and confirm background (cpm)

Remove and count filter _____open window (cpm)

Remove and count cartridge for one minute (scaler or ratemeter): _____open window (cpm)

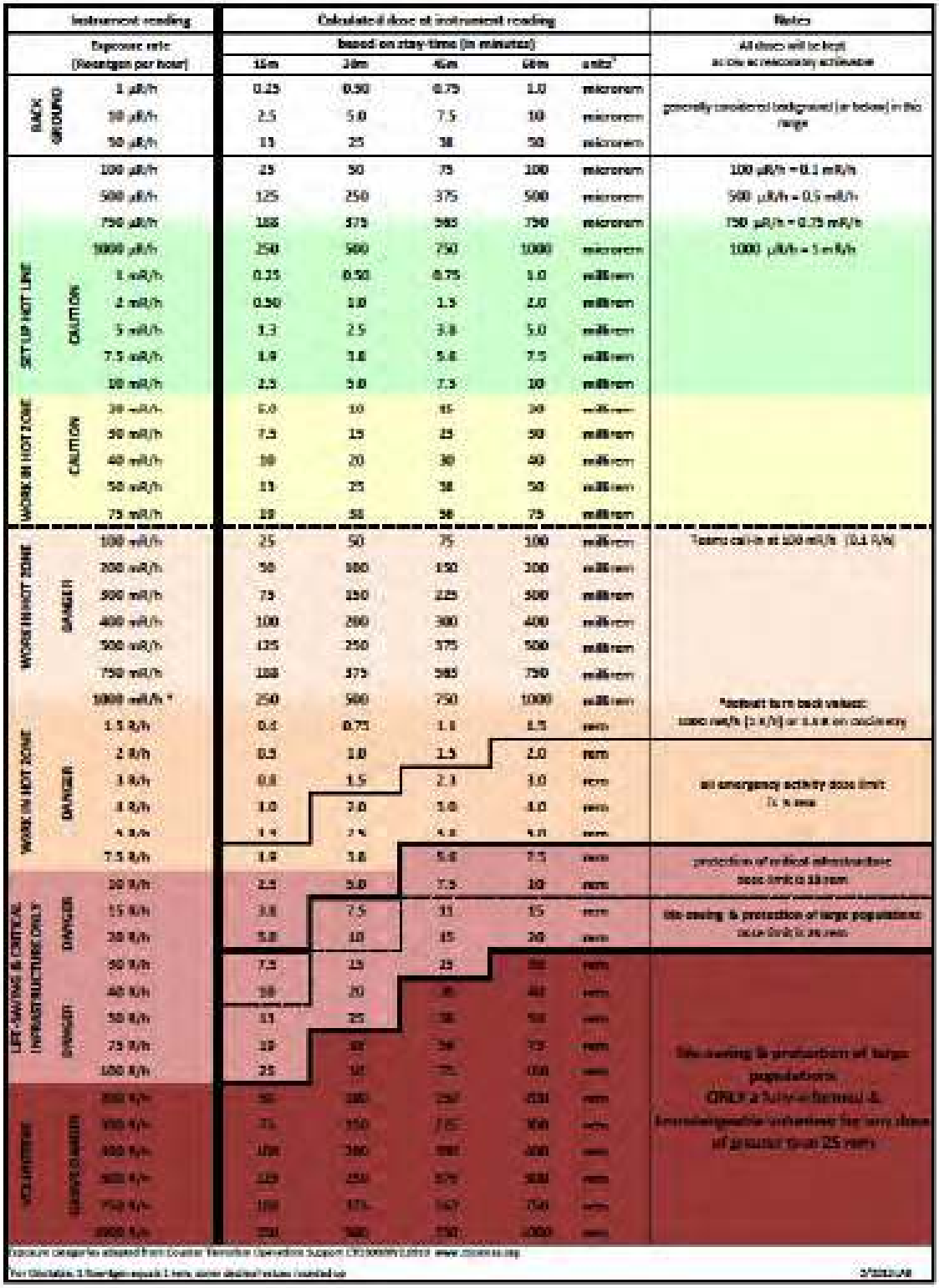
Check box if a soil sample was also collected at this site ☐

Tracking team director/dose assessment use:

$$\frac{(net\ count_{cpm})}{(sample\ volume_{L})}(K \cdot factor_{dpm/cpm})\left(4.5 \times E^{-10}\frac{1\ pCi}{(dpm-cc)}\right) = \_\_\_\_\_^{(1)}\ \frac{\mu curies}{cc}$$

Appendix 11

Stay-Time/Exposure Rate Table



Instrument reading		Calculated dose at instrument reading					Notes
Exposure rate (Roentgen per hour)		based on stay-time (in minutes)					All doses will be kept as low as reasonably achievable
		15m	30m	45m	60m	units*	
BACKGROUND	1 µR/h	0.25	0.50	0.75	1.0	microrem	generally considered background or below in this range
	10 µR/h	2.5	5.0	7.5	10	microrem	
	50 µR/h	13	25	38	50	microrem	
SET UP HOT LINE — CAUTION	100 µR/h	25	50	75	100	microrem	100 µR/h = 0.1 mR/h
	500 µR/h	125	250	375	500	microrem	500 µR/h = 0.5 mR/h
	750 µR/h	188	375	563	750	microrem	750 µR/h = 0.75 mR/h
	1000 µR/h	250	500	750	1000	microrem	1000 µR/h = 1 mR/h
	1 mR/h	0.25	0.50	0.75	1.0	millirem	
	2 mR/h	0.50	1.0	1.5	2.0	millirem	
	5 mR/h	1.3	2.5	3.8	5.0	millirem	
	7.5 mR/h	1.9	3.8	5.6	7.5	millirem	
	10 mR/h	2.5	5.0	7.5	10	millirem	
WORK IN HOT ZONE — CAUTION	30 mR/h	5.0	10	15	20	millirem	
	50 mR/h	7.5	15	25	50	millirem	
	40 mR/h	10	20	30	40	millirem	
	50 mR/h	13	25	38	50	millirem	
	75 mR/h	19	38	56	75	millirem	
WORK IN HOT ZONE — DANGER (!)	100 mR/h	25	50	75	100	millirem	Teams call-in at 100 mR/h (0.1 R/h)
	200 mR/h	50	100	150	200	millirem	
	300 mR/h	75	150	225	300	millirem	
	400 mR/h	100	200	300	400	millirem	
	500 mR/h	125	250	375	500	millirem	
	750 mR/h	188	375	563	750	millirem	
	1000 mR/h *	250	500	750	1000	millirem	*actual turn back values: case-by-case (> 1 R/h) or 0.5 R on cautionary
WORK IN HOT ZONE — DANGER	1.5 R/h	0.4	0.75	1.1	1.5	rem	
	2 R/h	0.5	1.0	1.5	2.0	rem	all emergency activity dose limit: 5 R max
	3 R/h	0.8	1.5	2.3	3.0	rem	
	4 R/h	1.0	2.0	3.0	4.0	rem	
	5 R/h	1.3	2.5	3.8	5.0	rem	
	7.5 R/h	1.9	3.8	5.6	7.5	rem	protection of critical infrastructure dose limit is 10 rem
LIFE-SAVING & CRITICAL INFRASTRUCTURE ONLY — DANGER	10 R/h	2.5	5.0	7.5	10	rem	life-saving & protection of large populations dose limit is 25 rem
	15 R/h	3.8	7.5	11	15	rem	
	20 R/h	5.0	10	15	20	rem	
LIFE-SAVING & CRITICAL INFRASTRUCTURE ONLY — EXTREME DANGER	30 R/h	7.5	15	23	30	rem	life-saving & protection of large populations ONLY & fully informed & knowledgeable volunteers for any dose of greater than 25 rem
	40 R/h	10	20	30	40	rem	
	50 R/h	13	25	38	50	rem	
	75 R/h	19	38	56	75	rem	
	100 R/h	25	50	75	100	rem	
	200 R/h	50	100	150	200	rem	
	300 R/h	75	150	225	300	rem	
	400 R/h	100	200	300	400	rem	
	500 R/h	125	250	375	500	rem	
	750 R/h	188	375	563	750	rem	
	1000 R/h	250	500	750	1000	rem	

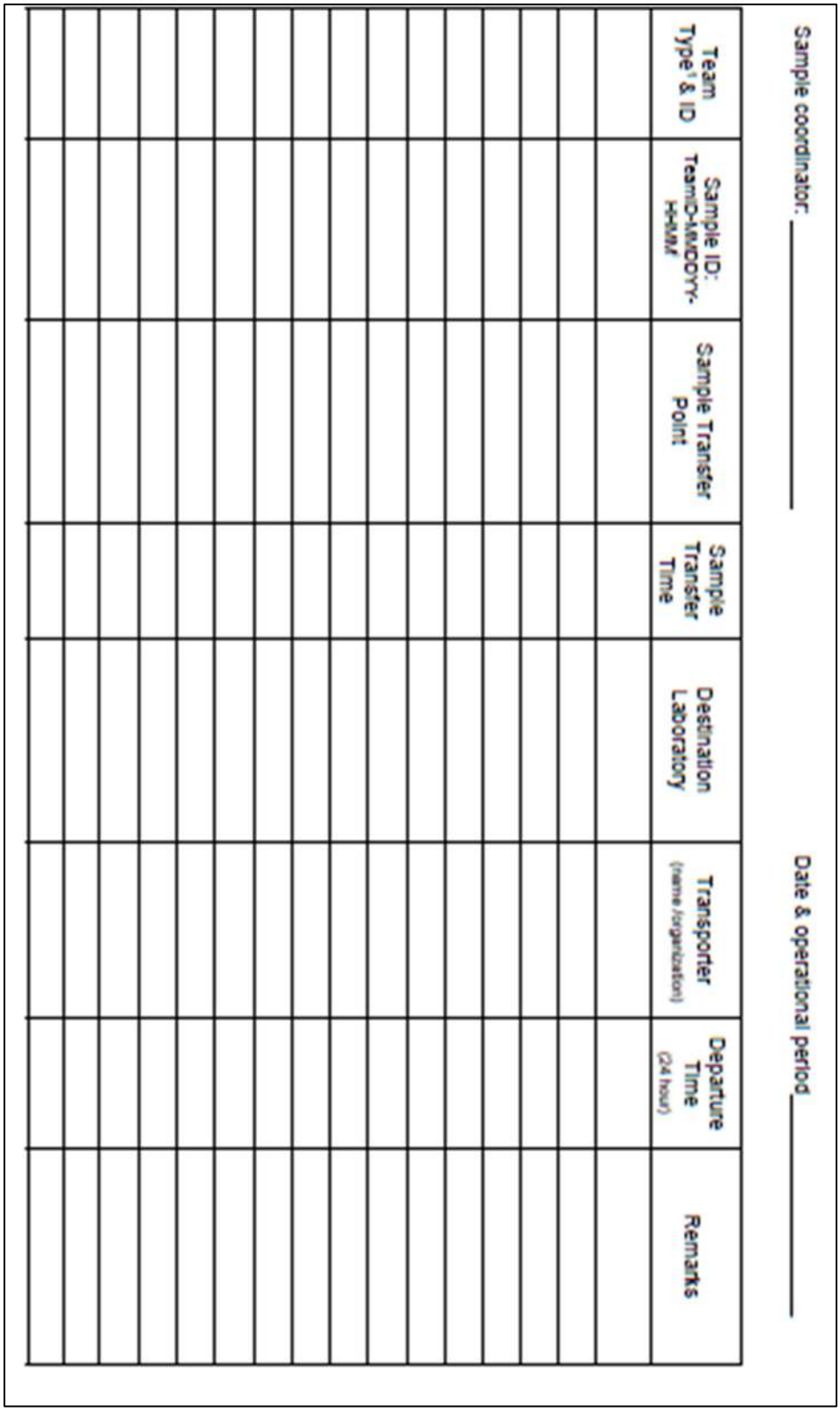
Exposure categories adapted from Counter Terrorism Operations Support (CTOS) www.ctosnet.org

For Clarification: 1 Roentgen equals 1 rem; some decimal values rounded up

3/2020 AR

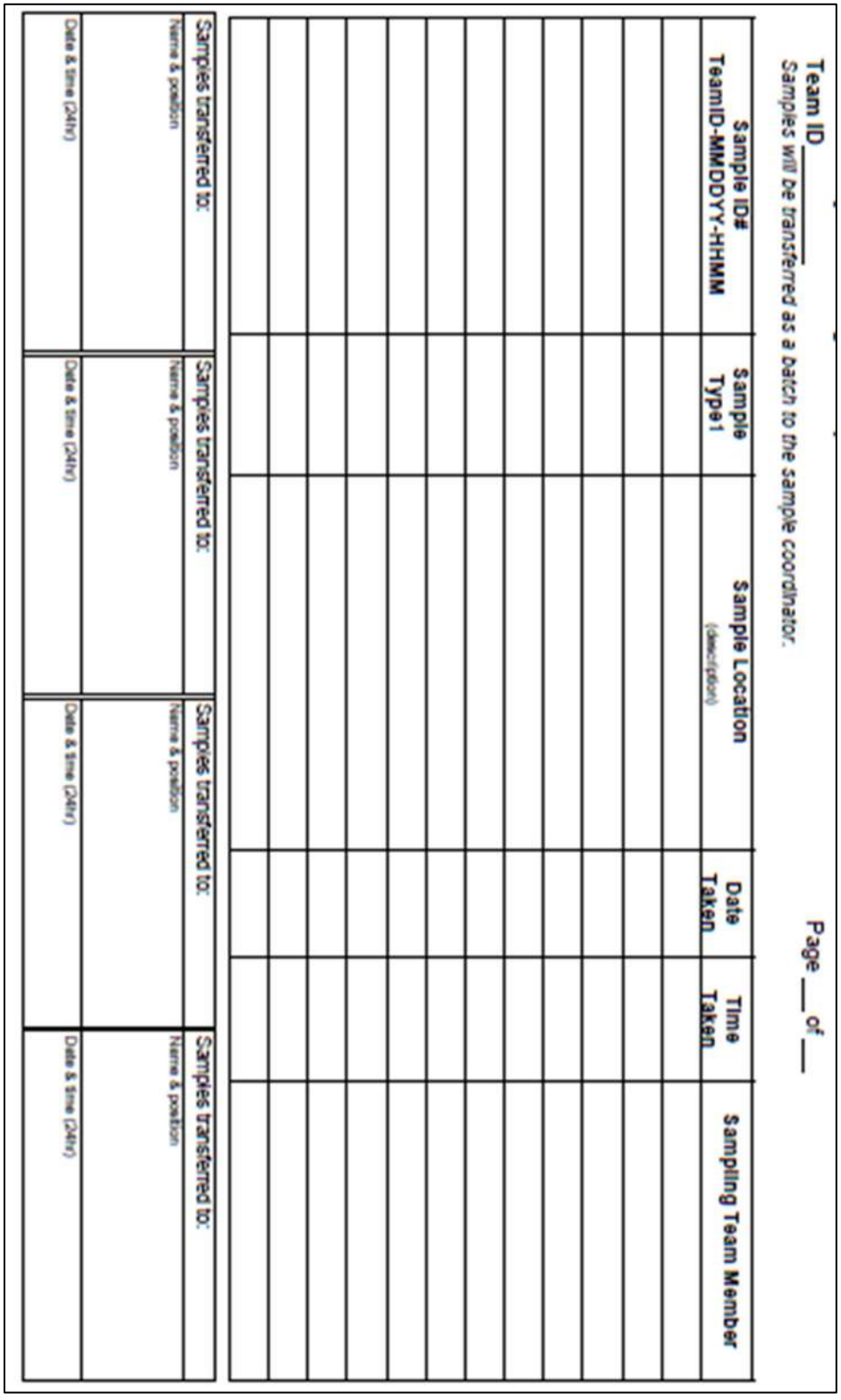
Appendix 12

Sample Collection Log



Appendix 13

Chain of Custody Form



Team ID _____

Samples will be transferred as a batch to the sample coordinator.

Page ___ of ___

Sample ID# TeamID-MMDDYY-HHMM	Sample Type1	Sample Location (description)	Date Taken	Time Taken	Sampling Team Member

Samples transferred to:	Samples transferred to:	Samples transferred to:	Samples transferred to:
Name & position	Name & position	Name & position	Name & position
Date & time (24hr)	Date & time (24hr)	Date & time (24hr)	Date & time (24hr)

Appendix 14

Dummerston Staging Area Response Kit Inventory Sheet

Team ID/Leader _____ Date: _____

Verify or update the minimum quantity of the following items (or equivalent).
Post-deployment, place the completed inventory on top of the kit.

Instrument Kit ID:				
If pre-deployment, inventory kit. Operability checks/steps are described in team member implementing procedure. If post-deployment, put instruments away in accordance with attachment 02. Do not seal this kit.				
Item	**Qty**	**Check if satisfactory**	**Initials**	**Comments**
RadEye-B20-ER (RadEye) in case	1			
RadEye-B20-ER (RadEye) H*10 dose filter	1			
Canberra Ultraradiac Plus, or equivalent high range survey meter	1			
Barium-133 source for iodine-131 response check	1			
Dosimeters, high-range, 0-20R or electronic dosimeter (e.g. dose-gard)	3			
Dosimeters, low-range, 0-1000 or 0-2000 mR	3			
Dosimeter charger	2			
Dosimeter of legal record	3			
Air sampler, portable, hi-volume with car battery connector cable	1			
Fuse, spare for air sampler	1			
cartridge, air sample, silver zeolite-for emergencies	10			
cartridge, air sample, TEDA-impregnated for exercises/training	10			
Filters, air sample, glass fiber, 50mm or 2", box of 20 or more.	1			
Batteries, D-cell	10			
Batteries-AAA	8			
Battery tester	1			
Calculator	1			
Flashlight	1			
Potassium Iodide (KI), 14 tablet package	1			

Personal Protective Equipment (PPE) Kit ID:				
If pre-deployment inventory: kit was found sealed, no further inventory needed.			Initial/Date:	
If post-deployment & inventory complete: kit met attachment 2 criteria and was sealed. Also fill-in below.			Initial/Date:	
Item	**Qty**	**Check if satisfactory**	**Initials**	**Comments**
Booties, disposable, pairs	20			
Boots, rubber overshoe type, pairs	3			
Coveralls, disposable with hood	6			
Glasses, safety, ANSI std.	3			
Gloves, disposable lab, box of 100	1			
Gloves, rubber, long sleeve, pairs	6			
Hard hats, safety, ANSI std.	3			
Respirators	4			
Vests, safety, fluorescent	3			

Radio Kit ID:				
If pre-deployment inventory: kit was found sealed, no further inventory needed.			Initial/Date:	
If post-deployment & inventory complete: kit met attachment 2 criteria and was sealed. Also fill-in below.			Initial/Date:	
Item	**Qty**	**Check if satisfactory**	**Initials**	**Comments**
Kenwood Model TK-8180HK UHF Mobile Radio, w/case, & power cable.	1			
note radio serial #				
Magnetic antenna base with cable	1			
Antenna with case	1			
Antenna gasket	1			
Radio Quick Reference Guide	1			
Owner's manual	1			
Garmin Kit ID:				
If pre-deployment inventory: kit was found sealed, no further inventory needed.			Initial/Date:	
If post-deployment & inventory complete: kit met attachment 2 criteria and was sealed. Also fill-in below.			Initial/Date:	

Document Kit ID:				
If pre-deployment inventory: kit was found sealed, no further inventory needed.			Initial/Date:	
If post-deployment & inventory complete: kit met attachment 2 criteria and was sealed. Also fill-in below.			Initial/Date:	
Item	**Qty**	**Check if satisfactory**	**Initials**	**Comments**
Emergency pass with lanyard	3			
Forms, **Radiation Exposure Record** (KI record and default dose limits)	6			
Emergency Worker Exposure Control Info Sheet	1			
Procedures, **Implementing**, set (team director, team member, sample coordinator)	1			
Procedures, **Attachments**, set	1			
Forms, Attachment-01, Operational Log	3			
Forms, Attachment-03, Tracking Team Inventory	10			
Forms, Attachment-05, Radioiodine Air Sampling/Site Characterization	20			
Forms, Attachment-07, Environmental Sample Identification Tag	20			
Forms, Attachment-08, Radiological Sample Chain of Custody	10			
Map, Vermont	1			
Paper, pad, 8-1/2 X 11 or stenographers size	1			
Grease pencil	2			
Pencils	2			
Pens, ink	2			
Waterproof marker, e.g. Sharpie	4			
Clipboard	1			
Gamma check source (cesium-137 or equivalent)	1			

Tool Kit ID:				
If pre-deployment inventory: kit was found sealed, no further inventory needed.			Initial/Date:	
If post-deployment & inventory complete: *kit met attachment 2 criteria and was sealed. Also fill-in below.*			Initial/Date:	
Item	**Qty**	**Check if satisfactory**	**Initials**	**Comments**
Alcohol swabs, box of 10 or more	1			
Bags, Whirl-pak brand or equivalent	50			
Bags, plastic, large, e.g. 39 gallon size, box of 10+	1			
Bags, plastic, med., e.g. 13 gallon size, box of 30+	1			
Bags, plastic, 1 gallon size, box of 30 or more	1			
Compass	1			
Smears, for wipe testing	50			
Foil, aluminum, 50 square foot roll	1			
Forceps, or tweezers	1			
Knife, utility with extra blades	1			
Measuring tape, e.g. 12 foot length	1			
Paper towels, roll	1			
Pliers	1			
Screw driver set	1			
Sheet, plastic contamination control	2			
Stop watch or other timing device	1			
Tape, duct, heavy duty, roll	1			
Tape, electricians, roll	1			
Tape, fluorescent, roll	1			
Toilet tissue, roll	1			

Appendix 15

HazMat Truck Radiological Kit Inventory Sheet

Item	Qty	Check if satisfactory	Comments
RadEye-B20-ER (RadEye) in case	1		
H*10 dose filter (RadEye)	1		
Canberra Ultra Radiac AN/UDR-13	1		
F&J High Volume Air Sampler with charcoal filter head and particulate filter paper	1		
Nuclear Research Corporation CDV 718	1		
Ludlum Model 26 hand-held friskers	5		
Dosimeters, direct reading, 0 - 1000 mR range	3		
Dosimeters, direct reading, 0 – 20R range	3		
Dosimeters of legal record (DLR)	3		
Charger, dosimeter, Model 6, pistol grip	1		
Charger, dosimeter, Model 5B, battery powered, box-type	1		
Batteries, AA	10		
Batteries, D-Cell	10		
Battery tester	1		
Calculator	1		
Flashlight, 3 D Cell	1		
Potassium iodide, 14 tablet packet	1		
Radiological and Nuclear Emergency Plan	1		
Radiological Emergency Sample Form Chem 314	20		
Sample Collection Log	5		
Radiological Exposure Record (Green Card)	3		
Emergency pass with lanyard	3		
Grease pencil	2		

Map, Vermont	1		
Pencils	2		
Pens, ink	2		
Waterproof marker, e.g., Sharpie brand	2		
Gamma check source, Cs-137 or equivalent	1		
Bags, plastic, medium, e.g. 13-gallon kitchen trash can size, container of 10 or more	1		
Bags, Whirl-pak brand, bag of 20	1		
Bags, plastic, large, e.g. 30+ gallon garbage can size, box of 10 or more	1		
Bottles, 4-liter, collapsible with lids	4		
Brush, long-handled scrub	1		
Brush, bottle	1		
Buckets, 4-liter, plastic	2		
Compass	1		
First Aid Kit	1		
Foil, aluminum, 50 square foot roll	1		
Forceps or tweezers	1		
Funnel, plastic, 6-inch	1		
Knife, utility with extra blades	1		
Knife, plastic putty type	1		
Measuring tape, 12-foot length or more	1		
Paper towels, roll	1		
Pitcher, 1 liter	1		
Pliers	1		
Cubitainers	4		
White Marking tape	1		
Straight screwdrivers	3		

Philips head screwdrivers	3		
Pruning shears	1		
Electrical tape	1		
Smears	25+		
Box cutter	1		
Spade	1		
Rope, 50 foot, 1/4" braided nylon	1		