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# Standard Practice for Radiological and Nuclear Emergency Response[1]

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## INTRODUCTION

Terrorist attacks around the world, including the attacks of September 11, 2001, and the continued proliferation of nuclear weapons bring the recognition that weapons of mass destruction (WMD), including the threats posed by radiological and nuclear weapons, remain a relevant concern. Since the attacks of 2001 and subsequent expressions of interest in acquiring radiological or nuclear weapons, or both, by terrorist groups and nation states, many jurisdictions have recognized the need for radiological and nuclear emergency preparedness. Incident response is still based on accepted procedures and safe work practices developed over the years, but it has become the norm to plan for both accidents and an intentional release of hazardous materials (including radioactive materials) designed to kill or injure, to cause destruction of property, or to deny access to areas, or combinations thereof. This practice provides guidance for the initial response to any type of incident complicated by radiation, and the basic radiation principles described will enable responders to perform their duties to save lives, protect the public and minimize radiation dose in keeping with the ALARA principle; however, this practice is not intended to replace the large body of work that has already been developed that addresses responses to accidents at commercial nuclear power plants, nuclear detonations, or large-scale radiological incidents and those that are included in the list of references.

This practice provides decision making considerations that jurisdictions can use to respond to incidents that involve radiological or nuclear materials. This practice also provides a consistent set of practices that can be incorporated into the development, planning, training, and implementation of guidelines for radiological emergency response. While the practice does not fully treat the complexities of large-scale radiological (for example, a radiological attack) or nuclear (for example, a nuclear attack) incidents, or commercial nuclear power plant (NPP) accidents, it refers jurisdictions to recent guidance documents and practices to incorporate into their own procedures for an initial response, with the assumption that concurrent requests are made to summon specialized regional, state, and federal radiological expertise and equipment, as appropriate to the incident. This practice does not incorporate intermediate or long-term recovery or mitigation considerations.

The following are key concepts associated with this practice:

- This practice applies to the initial response to an incident, which begins with the recognition of the radiological or nuclear nature of the incident and ends when emergency response actions cease or the response is supported by specialized regional, state, or federal response assets (if requested).
- In the first hours of the response, it is unlikely that significant levels of federal and state support will be on scene. This means that State, Local, Tribal, and Territorial (SLTT) jurisdictions and agencies must rely on their own immediately available assets, technical equipment, and training.
- This practice recognizes that response to all radiological incidents calls for assessing the risks to responders to determine whether the prospective benefit(s) justify an offensive mode of operations, and that response to a nuclear detonation calls for immediate sheltering for all emergency responders who do not have radiation detection equipment available;
- It adheres to a risk-based response; this means the guidance presented is intended to be coupled with the authority having jurisdiction's (AHJ) understanding of local hazards, vulnerabilities, and capabilities when developing its plans and guidance documents on the subject;
- It is compliant with the National Incident Management System (NIMS) and uses Incident Command System (ICS) common terminology. Full compliance with NIMS is recognized as an essential part of emergency response planning;
- It uses plain language: in developing this practice, every effort was made to ensure that the text,

including definitions, is presented in plain language according to Ref (**1**);[2]

- It acknowledges that response to a nuclear incident is far more complex than a radiological response and will require a different level of effort, time, and available resources to resolve;
- It notes that only a nuclear detonation requires responders to immediately seek shelter (if they have radiation detection instruments), to conduct only quick, critical lifesaving activities outside in areas where radiation exposure rates are greater than 10 R/h (if they have radiation instruments) or, if without radiation instruments, to remain in shelter until they are instructed to respond or relocate by an appropriate person in their chain of command (X4.2.2);
- While the dose accrued in an emergency is not subject to regulatory requirements and it is desirable to keep below 5 rem, in an emergency this may not be possible. This standard recognizes the dose in an emergency is managed under the Environmental Protection Agency guidance described in Section 4 and not by occupational limits. In addition to the Environmental Protection Agency guidance, there are numerous supporting references in this practice to implement that guidance, as cited in the paragraph below. In addition, Chapter 7 in Ref (**2**) contains a comprehensive discussion on the status of emergency workers with regulations and guidance (**1**);
- It is consistent with other planning guidance documents such as: Refs (**2-6**);
- It is intended to complement existing guidance (for example, Ref (**7**)) but it is not intended to replace existing guidance for responding to commercial nuclear power plant accidents. The state of preparedness for communities in close proximity to nuclear power plants far exceeds the minimum requirements and capabilities described in this practice; and
- It emphasizes the importance of working with or consulting with radiation safety professionals throughout the process of incorporating the contents of this practice into radiological and nuclear emergency response plans.

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[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.



## 1. Scope

1.1 This practice provides decision-making considerations for response to both accidental and intentional incidents that involve radioactive material. It provides information and guidance for what to include in response planning and what activities to conduct during a response. It also encompasses the practices to respond to any situation complicated by radiation in conjunction with the associated guidance for the specific type of incident.

1.1.1 The intended audience for the standard includes planners as well as emergency responders, incident commanders, and other emergency workers who should be protected from radiation.

1.1.2 The scope of this practice applies to all types of radiological emergencies. While it does not fully consider response to an NPP accident,[3] an explosive RDD, or nuclear detonation, detailed guidance to respond to such incidents is provided in other documents, such as those cited in the introduction. With respect to the guidance documents, this practice provides the general principles that apply to the broad range of incidents and associated planning goals but relies on the AHJ to apply and tailor their response planning based on those documents as well as the limitation of the personnel and equipment resources in the jurisdiction. In addition, the AHJ should use those documents to identify improvements to planning and resources to be better prepared for the more complex emergencies.

1.1.3 This practice does not expressly address emergency response to contamination of food or water supplies.

1.1.4 The Emergency Response Guide (ERG) published by the Department of Transportation provides valuable information for response to traffic accidents involving radioactive materials. For other radiological or nuclear incidents, however, the ERG may not provide adequate information on appropriate protective measures and should not be the sole resource used.

1.2 This practice applies to those emergency response agencies that have a role in the response to an accidental or intentional radiological or nuclear incident. It should be used by emergency response organizations such as law enforcement, fire service, emergency medical services, and emergency management.

1.3 This practice assumes that implementation begins with the recognition of a radiological or nuclear incident and ends when emergency response actions cease or the response is supported by specialized regional, state, or federal response assets.

1.4 AHJs using this practice should identify hazards, develop a plan, acquire and track equipment, and provide training consistent with the descriptions provided in Section 6.

1.5 While response to radiological hazards is the focus of this practice, responders must consider all hazards during a response; it is possible that non-radiological hazards may

[3] Local response to nuclear facility incidents should follow nuclear facility plans.

present a greater danger at an incident, particularly in incidents with wide area dispersion.

1.5.1 This practice does not fully address assessing the risks from airborne radioactivity. Equipment to determine this potential hazard is not widely available in emergency responder communities. Like other responses to unknown hazards, respiratory protection commonly used by responders is required until a complete hazard identification assessment is complete.

1.6 This practice is divided into the following sections:



1.7 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *Federal Standards:*[4]

10 CFR 20.1001 Standards for Protection Against Radiation
29 CFR 1910 Occupational Safety and Health Standards
29 CFR 1926.502 Occupational Safety and Health Standards
49 CFR 173 Shippers General Requirements for Shipments and Packages
18 U.S. Code §2332a Use of weapons of mass destruction
29 U.S. Code §654 Duties of employers and employees

2.2 *IEEE/ANSI Standards:*[5]

IEEE/ANSI N42.17AC Performance Specifications for Health Physics Instrumentation-Portable Survey Instrumentation for Use in Normal and Extreme Environmental Conditions
IEEE/ANSI N42.32 Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security
IEEE/ANSI N42.33 Portable Radiation Detection Instrumentation for Homeland Security
IEEE/ANSI N42.37 Training Requirements for Homeland Security Purposes using Radiation Detection Instrumentation for Interdiction and Prevention
IEEE/ANSI N42.42 American National Standard Data Format for Radiation Detectors Used for Homeland Security
IEEE/ANSI, N42.49A Performance Criteria for Alarming Electronic Personal Emergency Radiation Detectors (PERDs) for Exposure Control
IEEE/ANSI N42.49B Performance Criteria for Non-alarming Personal Emergency Radiation Detectors (PERDs) for Exposure Control
IEEE/ANSI N323AB Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments (Revision and Redesignation of IEEE/ANSI N323A-1997 and IEEE/ANSI N323B-2002)

2.3 *NFPA Standards:*[6]

NFPA 470 Hazardous Materials/Weapons of Mass Destruction (WMD) Standard for Responders
NFPA 472 Standard for Competence of Responders to Hazardous Materials Incidents
NFPA 3000 Standard for an Active Shooter/Hostile Event Response (ASHER) Program
NFPA Glossary of Terms (2021)

2.4 *Other Standards:*

ANSI/HPS N13.36 Radiation Safety Training for Workers[7]
EPA-402-K-22-008 Communicating Radiation Risks, Office of Radiation and Indoor Air[8]

## 3. Terminology

3.1 *Definitions:*

3.1.1 *Active Shooter/Hostile Event (ASHE), n*—an incident involving one or more individuals who are or have been actively engaged in harming, killing, or attempting to kill people in a populated area by means such as firearms, explosives, toxic substances, vehicles, edged weapons, fire, or a combination thereof. **NFPA 3000 (2021a)**

3.1.2 *ALARA (as low as reasonably achievable), n*—a principle of radiation protection philosophy that requires that exposures to ionizing radiation should be kept as low as reasonably achievable, economic and social factors being taken

[4] Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.

[5] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, http://www.ieee.org.

[6] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[7] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[8] Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

into account; the ALARA principle is satisfied when the expenditure of further resources would be unwarranted by the reduction in exposure that would be achieved (**8**).

3.1.3 *authority having jurisdiction (AHJ), n*—an entity that can create and administer processes to qualify, certify, and credential personnel for incident-related positions. AHJs include state, tribal, or federal government departments and agencies, training commissions, NGOs, or companies, as well as local organizations such as police, fire, public health, or public works departments (**1**).

3.1.4 *community reception center (CRC), n*—non-medical facility established to monitor members of the public for radioactive contamination and to provide decontamination if necessary (**8**).

3.1.5 *dangerous radiation zone, n*—an area where radiation levels exceed 10 R/h (0.1 Gy/h) (**8**).

3.1.6 *decision points, n*—predefined exposure rates or exposures at which a decision-maker must determine a path forward to maximize responder safety and public protection (**9**).

3.1.7 *decontamination, n—(1)* the removal of radionuclide contaminants from surfaces (for example, skin) by cleaning and washing (**8**); *(2)* the physical or chemical, or both, process of reducing and preventing the spread and effects of contaminants to people, animals, the environment, or equipment involved at hazardous materials/weapons of mass destruction (WMD) incidents. **NFPA 470**

3.1.8 *defensive mode, n*—an operating mode characterized as medium risk to emergency responders, in which responders do not have direct contact with the hazardous materials/weapons of mass destruction (WMD), focusing on safely controlling or limiting the effects of a release. **NFPA 470**

3.1.9 *dose, n*—a general term denoting the quantity of energy from ionizing radiation absorbed in a tissue or organ from either an external source or from radionuclides in the body (**10**).

3.1.10 *dose rate (also exposure rate), n*—a measure of dose delivered per unit time; dose rate can refer to any dose quantity (for example, absorbed dose, dose equivalent); dose rate is measured in units of R/h, mR/h, microR/h, and so forth with other units of radiation exposure and dose (rem, Sv, Gy, etc.) (**8**).

3.1.11 *dosimeter, n*—a small, portable instrument (such as a film badge, thermoluminescent dosimeter, or pocket dosimeter) used to measure and record the total accumulated personal dose of ionizing radiation (**11**).

3.1.12 *dosimetry, n*—the science or technique of determining radiation dose; strictly speaking, involving measured quantities, but also used informally to mean "dose assessment" (that is, involving measurements or theoretical calculations, or both) (**2**).

3.1.13 *emergency operations center (EOC), n*—a facility from which staff provide information management, resource allocation and tracking, or advanced planning support to personnel on scene or at other EOCs (for example, a state center supporting a local center), or combinations thereof (**1**).

3.1.14 *emergency response, n*—the performance of actions to mitigate the consequences of an emergency for human health and safety, quality of life, the environment, and property; it may also provide a basis for the resumption of normal social and economic activity (**12**).

3.1.15 *emergency response personnel (emergency response provider), n—(1)* personnel assigned to organizations that have the responsibility for responding to hazardous materials emergencies (NFPA Glossary of Terms); *(2)* federal, state, and local emergency public safety, law enforcement, emergency response, emergency medical (including hospital emergency facilities), and related personnel, agencies, and authorities (**13**).

3.1.16 *emergency worker, n*—anyone with a role in responding to the incident, whether a radiation worker previously or not, who should be protected from radiation exposure (**14**).

3.1.17 *evacuation, n*—organized, phased, and supervised withdrawal, dispersal, or removal of people from dangerous or potentially dangerous areas, and their reception and care in safe areas (**1**).

3.1.18 *high exposure rate, n*—exposure rate beyond which emergency response is not recommended for rescue operations unless the incident commander (IC) determines it can be carefully controlled for a short duration for priority operations (for example, lifesaving), and the emergency responder is informed of the hazards and consents to performing the operation(s); the recommendation of this practice is that areas in which exposure rate is greater than or equal to 100 R/h (1 Gy/h) be considered to have a high exposure rate; for the purposes of this practice, the term "high dose rate" is equivalent to "high exposure rate" (**12**).

3.1.19 *hot spot, n*—the region in a radiation/contamination area where the level of radiation/contamination is significantly greater than in neighboring regions in the area (**11**).

3.1.19.1 *Discussion*—A hot spot is a localized area with elevated radiation or contamination levels, or both, while a "zone" (for example, dangerous radiation zone) is an extended area. Thus, while the hot zone might have local areas in which radiation exposure rates exceed 10 R/h, these local areas will be posted as "hot spots" within the much larger hot zone.

3.1.20 *hot zone, n*—an area where *(1)* radiation levels exceed 10 mR/h (0.1 mGy/h); or *(2)* contamination levels exceed 60 000 dpm/cm$^2$ beta and gamma at 1.5 cm (~0.5 in.) from the surface being surveyed; or *(3)* alpha contamination levels exceed 6000 dpm/cm$^2$ at a distance of 0.5 cm (~0.25 in.) from the surface being surveyed, as measured with an alpha probe (**8, 15, 16**); all personnel working in the hot zone must receive training and wear personal protective equipment (PPE) appropriate for the risks (for example, contamination, dangerous atmosphere, radiation etc.) that are present.

3.1.21 *improvised nuclear device, n*—a device designed by terrorists to produce a nuclear detonation; this includes stolen and subsequently modified nuclear weapons but does not include stockpiled weapons in the custody of the military (**17**).

3.1.22 *incident command system (ICS), n*—a management system designed to enable effective and efficient domestic incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure (**1**).

3.1.23 *incident commander (IC), n*—the individual responsible for on-scene incident activities, including developing incident objectives and ordering and releasing resources; the incident commander has overall authority and responsibility for conducting incident operations (**1**).

3.1.24 *jurisdiction, n*—jurisdiction has two definitions depending on the context: *(1)* a *range or sphere of authority*: public agencies have jurisdiction at an incident related to their legal responsibilities and authority; jurisdictional authority at an incident can be political or geographical (for example, local, state, tribal, territorial, and federal boundary lines) or functional (for example, law enforcement, public health), or both; or *(2)* a *political subdivision*: (for example, municipality, county, parish, state, federal) with the responsibility for ensuring public safety, health, and welfare within its legal authorities and geographic boundaries (**1**).

3.1.25 *light damage zone (LDZ), n*—the area furthest from the site of a nuclear detonation, in which nearly all windows are shattered and building facades are damaged; most injuries in the LDZ are not life-threatening but there are likely to be many injuries from flying glass and debris (**4**).

3.1.26 *low exposure rate, n*—radiation exposure rate less than 10 mR/h (milliR/h) (0.1 mSv/h (milliSv/h)) at 1 m (3.3 ft) from the object or at 1 m (3.3 ft) above the ground or surface being surveyed; for the purposes of this practice, the term "low dose rate" is equivalent to "low exposure rate."

3.1.27 *multiagency coordination system (MACS), n*—an overarching term for the NIMS Command and Coordination systems: the incident command system (ICS), emergency operations centers (EOCs), the multiagency coordination (MAC) group/policy groups, and joint information centers (JICs) (**1**).

3.1.28 *nonintervention mode, n*—an operating mode used where the risk to emergency responders is greater than the benefit, in which responders do not operate near the hazardous materials/weapons of mass destruction (WMD) or container, focusing on public protective actions only and allowing the container or product to take its natural course. **NFPA 470**

3.1.29 *offensive mode, n*—an operating mode characterized as higher risk to emergency responders, in which responders could have direct contact with the hazardous materials/weapons of mass destruction (WMD), taking aggressive actions to control the release of hazardous materials/WMD. **NFPA 470**

3.1.30 *orphan source, n*—a radioactive source that is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen, or transferred without proper authorization (**18**).

3.1.31 *personal emergency radiation detector (PERD), n*—a high range, alarming, body-worn device capable of operating above 10 R/h and potentially up to 1000 R/h (0.1 Gy/h and potentially as high as 10 Gy/h). **IEEE/ANSI N42.49A**

3.1.32 *personal protective equipment (PPE), n*—the protective clothing and respiratory protective equipment provided to shield or isolate a person from the hazards encountered at hazardous materials/weapons of mass destruction incident operations. **NFPA Glossary of Terms**

3.1.33 *personal radiation detector (PRD), n*—a PRD is a pocket-sized battery-powered alarming electronic instrument that is worn on the body and used to detect photon-emitting, and optionally neutron-emitting, radioactive materials; PRDs have user-readable displays related to the intensity of radiation, but they are distinct from, and typically more sensitive than, electronic personal dosimeters, which are designed to measure the dose equivalent to workers occupationally exposed to radiation. **IEEE/ANSI N42.32-2016**

3.1.34 *preventive radiological/nuclear detection (PRND)* or *radiological/nuclear detection (RND), n*—capability to detect illicit radiological/nuclear materials and radiological/nuclear WMDs at the points of manufacture, transportation, and use, and to identify the nature of material through adjudication or resolution of the detection alarm; this does not include actions taken to respond to the consequences of the release of radiological/nuclear materials (such as response to the detonation of an RDD (**19**).



3.1.35 *radiation source, n*—radioactive material or byproduct that is specifically manufactured or obtained for the purpose of using the emitted radiation; such sources are commonly used in teletherapy or industrial radiography; in various types of industrial gauges, irradiators, and gamma knives; and as power sources for batteries (such as those used in spacecraft); these sources usually consist of a known quantity of radioactive material, which is encased in a man-made capsule, sealed between layers of nonradioactive material, or firmly bonded to a nonradioactive substrate to prevent radiation leakage (**11**).

3.1.35.1 *Discussion*—For the purpose of this document a "legitimate" radiation source is a source of radiation that is being used in the manner intended (for example, radioactivity administered to a nuclear medicine patient, radioactivity present in a "nuclear" soil gauge in use at a construction site, etc.).

3.1.36 *radiological dispersal device (RDD), n*—a device designed to spread radioactive material through a detonation of conventional explosive or other (non-nuclear) means (**9**).

3.1.37 *radiation exposure device (RED), n*—a device consisting of a large quantity of radioactive material clandestinely placed to expose people to ionizing radiation (**8**).

3.1.38 *rem, n*—(from Roentgen Equivalent Man) a measure of the biological damage caused by exposure to ionizing radiation, equal to the absorbed dose in rads multiplied by the radiation weighting factor for the type of radiation causing the exposure; 1 rem = 10 mSv (**8**).

3.1.39 *responder protection, n*—preventative measures taken to mitigate hostile actions against response personnel, resources, facilities, and critical information (**20**).

3.1.40 *roentgen (R), n*—a unit of exposure to ionizing radiation as determined by measuring the amount of ionization produced in a small volume of air (**21**); for the purpose of this practice, 1 R of exposure is equal to 1 rem, 1 rad, and 10 mSv of dose to the human body.

1000 micro-roentgen (microR or μR) = 1 milli-roentgen (mR)
1000 milli-roentgen (mR) = 1 roentgen (R), thus
1 000 000 microR = 1 roentgen (R)

3.1.40.1 *Discussion*—To improve clarity in communications, the unit roentgen may be spoken as "R" instead of pronouncing "roentgen." The SI prefix "micro" (one millionth) may be written as a lower case "u" or the phrase "micro" instead of the lower case Greek letter mu (μ) and may be spoken as either "micro" or "U." Similarly, the SI prefix "milli" (one thousandth) may be written as either "milli" or "m" and spoken as either "milli" or "M." For example, the value of 25 μR may be written as "25 uR" or "25 microR" and pronounced as "25 U-R" or "25 micro-R." Likewise, the value of 2 mR could be spoken as "2 M-R" or "2 milli-R."

3.1.41 *safety officer (hazardous materials), n*—the person who works within an incident command system (specifically, the hazardous materials branch/group) to ensure that recognized hazardous materials/weapons of mass destruction (WMD) safe practices are followed at hazardous materials/WMD incidents. **NFPA 470**

3.1.42 *secondary threats, n*—secondary threats include armed personnel or explosive devices that are placed to cause casualties among emergency personnel responding to incidents (**22**); see also *Active Shooter/Hostile Event*.

3.1.43 *shelter in place, n*—the strategy and tactics used to protect or shelter people or animals, or both, from a threat in a safe area, as an alternative to evacuation. **NFPA Glossary of Terms**

3.1.44 *termination, n*—that portion of incident management after the cessation of tactical operations in which personnel are involved in documenting safety procedures, site operations, hazards faced, and lessons learned from the incident. **NFPA Glossary of Terms**

3.1.45 *terrorism, n*—any activity that (A) involves an act that (i) is dangerous to human life or potentially destructive of critical infrastructure or key resources; and (ii) is a violation of the criminal laws of the United States or any state or other subdivision of the United States; and (B) appears to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping (**13**).

3.1.46 *transport index, n*—the dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation; the transport index is determined by multiplying the maximum radiation level in millisieverts (mSv) per hour at 1 m (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour (mrem/h) at 1 m (3.3 ft). **49 CFR 173.403**

3.1.47 *weapon of mass destruction (WMD), n*—defined in U.S. law as a weapon meeting one or more of the following four categories: *(1)* any "destructive device" (such as explosives, incendiary material, or poison gas in a bomb, grenade, rocket, missile, or mine); *(2)* any weapon that is designed or intended to cause death or serious bodily injury through the release, dissemination, or impact of toxic or poisonous chemicals, or their precursors; *(3)* any weapon involving a biological agent, toxin, or vector; *(4)* any weapon that is designed to release radiation or radioactivity at a level dangerous to human life. **18 USC §2332a**

3.1.47.1 *Discussion*—WMD is often referred to by the collection of categories that make up the set of weapons: chemical, biological, radiological, nuclear, and explosive (CBRNE). These are weapons that have a relatively large-scale impact on people, property, or infrastructure, or combinations thereof (**19**).

3.2 *Acronyms:*

3.2.1 *AHJ*—Authority Having Jurisdiction

3.2.2 *ALARA*—As Low as Reasonably Achievable

3.2.3 *ANSI*—American National Standards Institute

3.2.4 *ASHE*—Active Shooter/Hostile Event

3.2.5 *CBRNE*—Chemical, Biological, Radiological, Nuclear, and Explosive

3.2.6 *CDC*—Centers for Disease Control and Prevention

3.2.7 *CFR*—Code of Federal Regulations

3.2.8 *CRCPD*—Conference of Radiation Control Program Directors

3.2.9 *CTOS*—CTOS Center for Radiological/Nuclear Training at the Nevada National Security Site

3.2.10 *DHS*—Department of Homeland Security

3.2.11 *DOE*—Department of Energy

3.2.12 *DOT*—Department of Transportation

3.2.13 *DRZ*—Dangerous Radiation Zone

3.2.14 *EOC*—Emergency Operations Center

3.2.15 *EPA*—Environmental Protection Agency

3.2.16 *ERG*—Emergency Response Guidebook

3.2.17 *FEMA*—Federal Emergency Management Agency

3.2.18 *FRMAC*—Federal Radiological Monitoring and Assessment Center

3.2.19 *FSLTT*—Federal, State, Local, Tribal, and Territorial

3.2.20 *GM*—Geiger-Mueller

3.2.21 *HZ*—Hot Zone

3.2.22 *IAEA*—International Atomic Energy Agency

3.2.23 *IAP*—Incident Action Plan

3.2.24 *IC*—Incident Commander

3.2.25 *ICP*—Incident Command Post

3.2.26 *ICS*—Incident Command System

3.2.27 *ICRP*—International Commission on Radiation Protection

3.2.28 *ICRU*—International Commission on Radiation Units and Measurements

3.2.29 *IND*—Improvised Nuclear Device

3.2.30 *LDZ*—Light Damage Zone

3.2.31 *MACS*—Multiagency Coordination System

3.2.32 *MDZ*—Moderate Damage Zone

3.2.33 *NCRP*—National Council on Radiation Protection and Measurements

3.2.34 *NFPA*—National Fire Protection Association

3.2.35 *NIMS*—National Incident Management System

3.2.36 *NIST*—National Institute of Standards and Technology

3.2.37 *NPP*—Nuclear Power Plant

3.2.38 *NRF*—National Response Framework

3.2.39 *OSHA*—Occupational Safety and Health Administration

3.2.40 *PAGs*—Protective Action Guidelines

3.2.41 *PERD*—Personal Emergency Radiation Detector

3.2.42 *PPE*—Personal Protective Equipment

3.2.43 *PRD*—Personal Radiation Detector

3.2.44 *PRND/RND*—Preventive Radiological/Nuclear Detection or Radiological/Nuclear Detection

3.2.45 *R*—Roentgen

3.2.46 *R/h*—Roentgen per hour

3.2.47 *RDD*—Radiological Dispersal Device

3.2.48 *REAC/TS*—Radiation Emergency Assistance Center/ Training Site

3.2.49 *RED*—Radiation Exposure Device

3.2.50 *REMM*—Radiation Emergency Medical Management

3.2.51 *RIID*—Radio Isotope Identifier

3.2.52 *SDZ*—Severe Damage Zone

3.2.53 *SI*—International System of Units

3.2.54 *SOP*—Standard Operating Procedure

3.2.55 *SLTT*—State, Local, Tribal, and Territorial

3.2.56 *TI*—Transport Index

3.2.57 *US*—United States

3.2.58 *USC*—United States Code

3.2.59 *WMD*—Weapon of Mass Destruction

## 4. Summary of Practice

4.1 This practice is based on existing resources and experience related to the development of radiological emergency response guidelines. This experience base is translated into a practice to guide responder agencies toward the goal of building operational guidelines for the first hours of radiological or nuclear incident response. The practice is intended to enhance the ability, knowledge, and understanding of personnel, agencies, or departments that are responsible for responding to a radiological or nuclear incident.

4.2 This practice shall be incorporated as a reference in emergency operation centers, emergency operation plans, and multiagency coordination systems to assist in policy formulation and development of strategic objectives consistent with the objectives and needs of the incident commander throughout the incident. In incidents encompassing multiple agencies, multiple victims, and damage to environment and infrastructure, the EOC or MACS, or both, would be operating at least at the local level. It is imperative that representatives at the EOC or MACS, or both, be aware of and understand this practice and operate in concert with emergency response communities that adopt this practice.

4.3 The flowchart shown in Fig. 1 summarizes the actions to take during a radiological or nuclear response. Note that, as discussed in Section 7, the default response to a nuclear detonation should be to immediately seek safe shelter, instructing members of the public to seek shelter as well. Once sheltering, emergency responders who have radiation survey equipment should use their instruments to assess radiation exposure rates outdoors and should respond in accordance with the decision points noted in Fig. 1 and discussed in Table 1. In a nuclear detonation incident, emergency responders who do not have radiation detection instruments should continue to shelter for 12 h to 24 h, until they receive radiation instruments, or are provided situational awareness of where the dangerous levels of radiation are present and where it is safe to respond, how to avoid lethal levels of radiation, and which locations are safe to conduct response or relocation activities (**5**). In contrast, during a response to a radiological (non-nuclear) emergency, responders are encouraged to conduct lifesaving activities as quickly as possible (even if no personal detection equipment is available), since it is unlikely that radiation levels are high enough to present an immediate hazard during a short period of time.

4.4 A discussion of the short- and long-term health effects of radiation exposure is found in Appendix X1, in Table X1.1, and Table X1.2.

4.5 This practice follows a risk-based response approach because the risk of developing short-term (for example, radiation sickness, skin burns) or long-term (for example, cancer) health effects is proportional to the amount of radiation dose received; because the amount of radiation dose received is related to the dose rate or exposure rate in which one works; and because radiological safety recommendations are provided in terms of reducing radiation exposure in accordance with the ALARA principle.

## 5. Significance and Use

5.1 It is essential for response agency personnel to plan, develop, implement, and train on standardized guidelines that encompass policy, strategy, operations, and tactical decisions prior to responding to a radiological or nuclear incident. Use of this practice is recommended for all levels of the response structure.

5.2 Documents developed from this practice should be reviewed and revised as necessary on a two-year cycle or according to each jurisdiction's normal practices. The review should consider new and updated requirements and guidance, technologies, and other information or equipment that might have a significant impact on the management and outcome of radiological incidents.

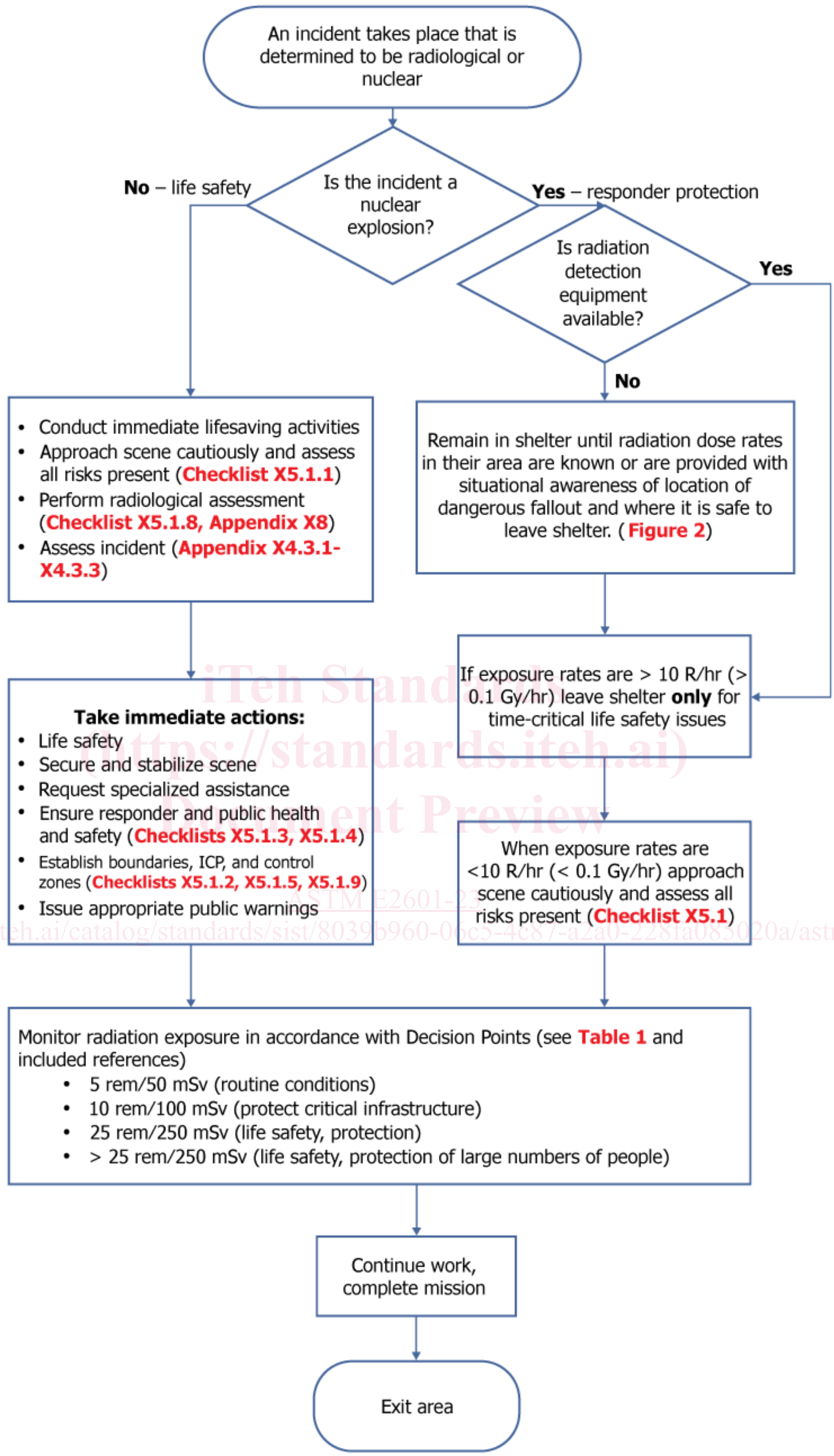


**FIG. 1 Radiological/Nuclear Emergency Response Flowchart**

**TABLE 1 Radiation Exposure and Exposure Rate Guidelines for Those Responding to Radiological or Nuclear Emergencies**

NOTE 1—For the purpose of this practice, 1 R of exposure is equal to 1 rem, 1 rad, and 10 mSv of dose to the human body.

| Guideline | Activity | Condition |
|---|---|---|
| | Exposure or dose rate in area (R/h, Sv/h) | |
| >10 mR/h (0.1 mGy/h)[F, G, I] | Work in HZ | All personnel working in HZ should have appropriate training and PPE (including radiation dosimeters) for all hazards they are expected to encounter. |
| >10 R/h (0.1 Gy/h)[A, B, G] | Work in DRZ – lifesaving activities | Entry into the DRZ should only be made to conduct lifesaving actions or attempting to prevent a catastrophic situation and with the informed consent of those making the entry. |
| >100 R/h (1 Gy/h)[A, B, G] | Work in DRZ – to perform lifesaving actions or when attempting to prevent a catastrophic situation. | In addition to the requirements to enter the DRZ, entry should only be made with the permission of the Incident Commander. |
| | Total dose to the worker (rem, Sv)[J] | |
| 5 rem (50 mSv)[A, C, D, E, F, H, I] | Occupational limit for radiation workers under routine circumstances | All reasonably achievable actions have been taken to minimize dose. |
| 5 rem to 10 rem (50 mSv to 100 mSv)[A, B, E, I] | Protecting critical infrastructure necessary for public welfare (for example, a power plant) | Exceeding 5 rem (50 mSv) is unavoidable and appropriate actions have been taken to reduce dose. Monitoring is available to project or to measure the dose to individuals. |
| 10 rem to 25 rem (100 mSv to 250 mSv)[A, B, E, H, I] | Lifesaving or protection of large populations | Exceeding 5 rem (50 mSv) is unavoidable and all appropriate actions have been taken to reduce dose and with the informed consent of those making the entry. Monitoring is available to project or to measure dose. |
| 25 rem to 50 rem (500 mSv)[A, B, E, H, I] | Lifesaving or protection of large populations | All conditions for exceeding a dose of 25 rem have been met and those making the entry are fully aware of the risks involved. |
| 50 rem to 100 rem (1 Sv)[A, B, E, G, H, I] | Lifesaving or protection of large populations | |

[A] Medical monitoring should be considered for potential doses in excess of 5 rem (50 mSv).
[B] In the case of very large incidents (for example, nuclear detonation), the IC should consider raising the dose guidelines to prevent large-scale loss of life and widespread destruction.
[C] From EPA Protection Action Guidelines (**14**).
[D] From NCRP 1993 (**23**).
[E] From ICRP Publication 96 (**18**).
[F] From CRCPD 2006 (**16**).
[G] From IAEA 2006 (**12**).
[H] From DHS 2008 (**24**).
[I] From NCRP 2010 (**8**).
[J] According to Ref (**14**), any dose in excess of 5 rem (50 mSv) is assumed to occur only once in a lifetime and that any responder receiving a dose in excess of 5 rem (50 mSv) "should not take part in the later stages of the response."



## 6. Prerequisites for Radiological or Nuclear Emergency Response

6.1 AHJs over a radiological or nuclear response are responsible for providing the planning, resources, training, and safety necessary to implement standardized procedures.

6.2 *Planning*—AHJs shall determine the specific requirements and planning elements for a response plan. The plan, and the documents that have significant impact on it or those that flow from it, shall be revised as necessary. Radiological and nuclear response plans should consider the guidelines and other information summarized in Table 1 and the cited references, and should address the following:

6.2.1 *Planning the Response to Radiological Incidents*—Radiological incidents and incident responses rarely pose an immediate threat to life or health and only rarely expose responders to dangerously high levels of radiation. For this reason, radiological response plans can focus on immediate response to the scene. Because radiological incidents can vary from a minor accident to a terrorist attack, a radiological incident response plan must be able to accommodate incidents that pose little to no risk as well as those that may pose a risk to responders.

6.2.1.1 The following points will help to differentiate between these possibilities.

*(1)* Incidents in which radioactive materials are unlikely to pose a risk because:

*(a)* The radioactive materials are contained,

*(b)* The source is legitimate,[9] and

*(c)* The source does not presently pose an exposure risk to human health or the environment, or

*(2)* Incidents in which radioactive materials may pose a risk because:

*(a)* The radioactive materials have been released, have the potential to be released, present an exposure hazard, or all of these; and

*(b)* Radiation exposures or contamination, or both, are above typical background levels; or

*(c)* Implementation of protective actions may be necessary.

6.2.1.2 The immediate default response to radiological incidents should focus on lifesaving tasks (that is, saving lives through rescue operations), life safety practices and precautions intended to keep members of the public and emergency responders safe, and stabilizing the scene. Radiological incidents and incident response rarely pose an immediate threat to life or health. Therefore, rescue, lifesaving, first aid, fire suppression, and addressing other immediate hazards are a higher priority than measuring radiation levels (**25**).

[9] For the purposes of this document, term "legitimate radioactive source" refers to a radioactive source that is under regulatory control or that can be identified as natural, medical, or industrial in nature and that is being used as intended. For example, Cs-137 that is identified and is found to be a source in a soil density gauge in the possession of its licensed user is a "legitimate" source, while Cs-137 found in a dumpster is out of regulatory control and not a legitimate source.

Accordingly, responders who arrive at the scene should conduct initial entries as required in order to save lives, perform rescues, and attend to other vitally important lifesaving tasks, even if there are no dosimeters or radiation survey instruments available at the scene. When radiation levels have decayed sufficiently to permit responding safely, these guidelines apply to nuclear detonations as well. The radiological plan should include recommendations for exposure rate decision points that are not considered absolute action levels but rather are incident management guidelines. Note that different agencies and advisory bodies have recommended different dose limits and dose or dose rate decision points. These are summarized in Table 1. In addition to Refs (**8, 12, 14, 16, 18, 23 and 24**), jurisdictions should consult with their state radiation control programs and with local radiation safety professionals when developing their local dose and dose rate limits or decision points, or both.

NOTE 1—Follow the ALARA principle to keep exposures as low as reasonable for the assigned task or mission (see Table 1).

6.2.2 *Planning the Response to a Nuclear Detonation*—Response to nuclear detonations will differ from response to radiological incidents because of the dangerously high radiation levels that can be encountered in the fallout plume. An effective local nuclear detonation plan will not be able to document all response problems and solutions in advance. Thus, the immediate response to a nuclear detonation must be to protect emergency responders to ensure they are not exposed to lethal levels of radiation and to establish a process for prioritizing identified problems and coordinating the collective allocation of scarce resources with partner jurisdictions, states, and regional organizations. A catastrophic incident requires preparedness for a response where the status of command, control, and communication are all questionable in the early minutes. Over the hours and days that follow, saving lives in concert with re-establishing coordination will be the hallmark of success (**4**). Therefore, response to a nuclear detonation focuses at first on responder protection (discussed in 6.2.2.1):

6.2.2.1 The default response to a nuclear detonation will include (see Fig. 1, Section 7, and Appendix X2):

*(1)* Responder protection details (see 6.2.2.1 – 6.2.2.5 and Section 7);

*(2)* Notification details;

*(3)* Definition of radiological zones (for example, HZ, DRZ); and

*(4)* A scalable approach for decontamination response for incidents where contamination has been identified (see Appendix X1 and the Radiation Emergency Medical Management (REMM) website).[10]

NOTE 2—Initial responses to a nuclear detonation will focus on responder protection.

6.2.2.2 Those response personnel who DO NOT have access to appropriate radiation detectors and who ARE NOT trained in their use must immediately:

*(1)* Go inside,

*(2)* Stay inside, and

*(3)* Follow the protective action recommendations for the public until receiving situational awareness of the location of dangerous levels of radiation, via the media, the emergency alert system or wireless emergency alert system, etc., for recommended response actions. Emergency response equipment radios, smart phones, computers, and the infrastructure that supports their operation can be affected by an electromagnetic pulse associated with a nuclear detonation. Interference with electronic components (for example, latching upsets) could span a distance of several miles. Regaining operation from equipment upsets may require cycling of power or rebooting (**26**). It may be necessary for the AHJ and emergency responders to use auxiliary communications technologies such as satellite telephones, satellite internet, amateur radios, and other similar modalities.

6.2.2.3 For those response personnel who DO have access to appropriate radiation detectors and who ARE trained in their use, if radiation exposure rates are lower than 10 R/h and it is safe to do so:

*(1)* Assist the public and evacuate personnel to safety;

*(2)* Conduct selected fire suppression necessary to support the evacuation; and

*(3)* Control exposure and exposure rate as noted in Table 1.

6.2.2.4 When responding to a radiological incident, responders must remain aware of the following when evaluating the potential risks associated with entering any area with high radiation exposure rates:

*(1)* The DRZ, where the exposure rate exceeds 10 R/h (100 mSv/h), is very hazardous, so response operations within it must be justified, planned, and optimized to minimize radiation exposure.

*(2)* Unless engaged in lifesaving activities, responders should refrain from undertaking missions in potentially dangerous areas until radiation levels are known and responder exposures monitored.

*(3)* Responders should not enter any areas in which the exposure rate exceeds 100 R/h (1 Sv/h) unless necessary to save lives or perform other vital tasks, and then, only with the permission of the IC and the informed consent of those making the entry (see Appendix X1 – Appendix X4).

*(4)* Ref (**14**) assumes responders will receive only one such exposure during their lifetime and recommends that any responder who receives greater than 5 rem (50 mSv) "not take part in the later stages of the response that might significantly increase their dose."

*(5)* Table 1 and the accompanying notes use units of Roentgen (R), rad (r), rem, Gray (Gy), and Sieverts (Sv). For the purposes of this practice, 1 Roentgen = 1 rad = 1 rem = 10 mGy = 10 mSv.

6.2.2.5 There is no universally agreed-upon turn-back limit for lifesaving activities, so planners are strongly encouraged to work with radiation health experts and first responders to identify decision points that are appropriate for their operational protocols. When evaluating decision points, the following points should be considered:

*(1)* Recommendations for total dose decision points and radiation dose management (see Appendix X1). Refs (**14, 16, and 23**) recommend that the total radiation dose to those

[10] Access at https://remm.hhs.gov/.

engaged in emergency response activities should not exceed a dose of 50 rem (0.5 Sv) whenever possible. In addition, some organizations note specific circumstances under which it might be acceptable for personnel to exceed a radiation dose of 50 rem (0.5 Sv).

*(2)* Ref (**12**) recommends the dose should not exceed 100 rem (1 Sv) for lifesaving efforts while both NCRP 2010 (**8**) and (**18**) recommend against setting firm dose limits for the conduct of lifesaving activities, nor is the concept of a dose limit applicable under emergency conditions (10 CFR 20.1001(b)). In all cases, emergency responders should be made fully aware of the risks of both early and late (for example, cancer) health effects from such large doses, should receive this exposure voluntarily, and should minimize the time spent in the highest-dose rate areas.

*(3)* The dose and dose rate values in Table 1 are provided as examples to help guide the IC when determining applicable decision points, considering the response situation using the ALARA principle.

6.3 *Resources*—The AHJ shall conduct equipment and resource needs assessments to determine the agency's requirements for radiation detection equipment, monitoring equipment, dosimetry, and specialized PPE; shall develop a response profile that details the equipment requirements; and shall acquire the necessary equipment.



6.3.1 Because the HZ and DRZ are areas with elevated levels of radiation and contamination, personnel must have proper training, equipment, and PPE prior to working in them. As the DRZ is within the HZ, personnel entering the DRZ will already meet the requirements for HZ entry; jurisdictions may choose to impose additional requirements for personnel working in the DRZ in recognition of the higher radiation levels. Minimum equipment prerequisites for teams working in these zones (for example, hose team, survey team, medical team) are summarized in 6.3.1.1 – 6.3.1.3.

6.3.1.1 Contamination measuring instrument(s) shall include an instrument, or combination of instruments, able to detect alpha, beta, and gamma radiation and shall have sensitivity equivalent to or greater than a pancake Geiger-Mueller (GM) instrument (see Appendix X1).

6.3.1.2 Exposure rate instrument(s) shall include an instrument, or combination of instruments, able to measure a range of exposure rates from 0.005 mR/h to more than 100 R/h, possibly up to 1000 R/h (0.05 uSv/h to more than 1 Sv/h, possibly 10 Sv/h) for establishing the HZ boundary and operating within the HZ (see Appendix X1). Radiation detectors purchased for preventative radiological/nuclear detection (PRND) can also be used for radiological and nuclear emergency response (consequence management). Refer to guidance on the use of this class of instruments (**27-29**). Exposure rate measurements and occupancy time can be used to effectively estimate integrated radiation exposure as well as to provide group dosimetry for responders who all are working in the same vicinity if it is not practical to issue passive dosimeters to each individual (**2 and 6**).

6.3.1.3 Dosimetry devices shall include either a passive dosimeter that cannot provide real-time information to the wearer or an active dosimeter (such as personal emergency radiation detector (PERD)) that can measure and display the integrated dose to a person from external radiation. In the absence of an active or passive radiation dosimeter, it is possible to estimate radiation exposure as noted in 6.3.1.3*(1)* and in Appendix X3. Since it is not practical to issue a dosimeter to every responder before exposure to radiation occurs, the following should be issued to facilitate group dosimetry: *(1)* one dosimeter or one dose rate meter per team, or *(2)* a dose rate meter and occupancy time of the entry per team. It is recommended that an active dosimeter have a programmable alarming function (**2, 6**, IEEE/ANSI N42.49A, and Appendix X1).

*(1)* Dosimetry is the process of measuring radiation dose using radiation dosimeters, monitoring radiation exposure using, "radiation detectors that provide real time measurements of the radiation exposure rate environment" (**2**), or radiation dose reconstruction through performing a retrospective assessment of dose to an individual, a group, or both. Ref (**2**) notes that, "Assigning a dose to an individual from an activity or timeframe does not require any specific equipment or device but should be based on the best data and information obtainable…a dosimeter is not required to perform (the) dosimetry (process)." Two examples are provided in Appendix X3.

*(2)* With the exception of fallout from a nuclear explosion, incidents involving exposure to radiation rarely pose an immediate danger to life or health. Therefore, rescue, lifesaving, first aid, fire suppression, and addressing other hazards are a higher priority than measuring radiation levels (**25**). Accordingly, responders who arrive at the scene should conduct initial entries as required in order to save lives, perform rescues, and attend to other vitally important lifesaving tasks, even if there are no dosimeters or radiation survey instruments available at the scene.

*(3)* When these responders have completed their work they should not re-enter the HZ until their radiation exposure has been estimated based on their time of entry, the duration of their entry, and an estimate of the maximum radiation dose rate during entry into the affected area.

*(4)* Once dosimeters and radiation instruments are available for use at the scene, all responders entering the HZ must be monitored (**2 and 6**).

6.3.2 Instruments shall be calibrated and maintained in accordance with applicable and relevant standards, including the recommended maintenance frequency (**30**). Recommendations for appropriate PPE for emergency responders can be found in Ref (**14**), NFPA 472, and in the Code of Federal Regulations (29 CFR 1910), among other places.

6.4 *Training*—Personnel who have a responsibility for a radiological response shall have the level of training that will enable them to perform work tasks safely. The training shall include proper use of equipment and guidelines developed by the AHJ. Emergency workers shall use hazard risk assessments to institute a safe working environment. The minimum level of training for responders shall include information from the current version of the following documents:

6.4.1 NIMS ICS (**1**),

6.4.2 Occupational Safety and Health Administration (OSHA) Hazardous Waste Operator (HAZWOPER) first responder operational level as described in 29 CFR 1910.120(q) and General Duty Clause (29 U.S. Code Section 654, Section 5),

6.4.3 Any FSLTT regulatory requirements that apply,

6.4.4 Relevant information from important guidance and foundational documents (such as those listed in Refs (**2-6**)), and how this is reflected in jurisdiction response plans,

6.4.5 The following NFPA 470 chapters:

6.4.5.1 Chapter 6: Competencies for Hazardous Materials/WMD Operations Level Responders;

6.4.5.2 Chapter 7: Professional Qualifications for Hazardous Materials/WMD Operations Level Responders;

6.4.5.3 Chapter 8: Competencies for Hazardous Materials/WMD Operations Level Responders Assigned Mission-Specific Responsibilities (for example, minimum PPE, monitoring, and detection); and

6.4.5.4 Chapter 9: Professional Qualifications for Hazardous Materials/WMD Operations Level Responders Assigned Mission-Specific Responsibilities.

6.5 *Safety*—Safety considerations by the AHJ are paramount to the success of the operation. The following safety issues shall be considered in planning and operational activities:

6.5.1 Ensure the proper equipment has been assembled and maintained for the mission; and

6.5.2 Monitor strategic command operations and ensure use of self-protection concepts:

6.5.2.1 Employ ALARA principles, which include time, distance, and shielding (see Appendix X1 and Appendix X3);

6.5.2.2 Determine the feasibility of lifesaving operations based upon elapsed time, geographic distance from source, dose, exposure rate, stay times, and difficulty of lifesaving operations (see Appendix X1); and

6.5.2.3 Definitions, characteristics, and safe work practices for the various radiation and damage zones (for example, DRZ, LDZ).

6.6 Develop and document site emergency response plans as defined in 29 CFR 1910.120(q) using dose reports, dose reports with associated injury reports, and personnel dosimeter logs (see X1.4).

6.7 *Medical*—Confirm that the designated medical receiving facility is familiar with and capable of implementing the medical management of contaminated victims and that the medical receiving facility is willing to accept contaminated patients for treatment.

## 7. Nuclear Detonation Response

7.1 A nuclear detonation is unique, dangerous, and destructive such that it stands apart from any other accidental or malevolent incident that involves radiation. Depending on the yield of the weapon and height of burst, a nuclear detonation will cause substantial structural and infrastructure damage, third-degree burns, and dangerous levels of radiation from fallout. Depending on the yield and height of burst, exposure rates higher than 10 R/h (0.1 Sv/h) can occur at distances of a few to tens of miles from the detonation. Because the location and extent of fallout will not be known in the early period after the detonation, if responders initiate an immediate response, they could unknowingly be exposed to life-threatening doses of radiation. Because of this unique hazard environment, the initial response tactics to a nuclear detonation are different from those for any other emergencies involving radiation or radioactive material, and may be counter-intuitive to emergency responders. The two (different) response strategies to a nuclear detonation and all other radiological incidents are shown graphically in the flowchart in Fig. 1.

7.2 In the nuclear detonation operating environment, responders who are closer than 10 miles (or further for high-yield devices) from the detonation may be exposed to dangerous levels of radiation; without radiation detectors, responders cannot identify this hazard. Accordingly, responders without radiation instruments must follow the same protective action recommendations as the public and immediately proceed to an adequate shelter until they have gained situational awareness about radiation levels in their area.

7.3 To avoid becoming victims themselves, unless informed that they are not in an area impacted by fallout, responders without radiation detection equipment should plan on sheltering for up to 24 h to allow radiation levels to drop to operational exposure levels less than 10 R/h (0.1 Sv/h). *This approach to ensure responder protection and safety will ultimately maximize the available number of responders and their opportunities to save lives and alleviate human suffering.*

7.4 *Responder Protection:*

7.4.1 Because the presence of radiation cannot be known without proper instruments, it is possible to be exposed to an incapacitating or fatal dose of radiation without knowing it has occurred. Depending on a responder's location, dangerous levels of radiation could arrive within minutes. Therefore, responders should promptly seek adequate shelter and urge the public they encounter to do the same, albeit without delaying their arrival to the shelter. Once in an adequate shelter, responders must avoid going back outside until radiation levels have dropped to safe levels or until they receive instructions that it is safe to begin response activities.

7.4.2 The need to conduct uncontrolled entry into and egress from the HZ is especially likely following a nuclear detonation because the lifesaving phase may extend for days, and the HZ and DRZ boundaries (which might initially cover a significant geographical area) will rapidly change (that is, expand then reduce) during the first 12 h to 48 h, as the fallout deposits and then rapidly decays.

7.4.3 Key points essential to responder safety are summarized in Fig. 2, with additional details presented in Table 1. Awareness of these key points can save many lives.