

Planning Guidance for Response to a Nuclear Detonation

Third Edition (Draft)

December 2021



FEMA

- 1 This guidance was developed by a Federal interagency committee led by the Federal Emergency
- 2 Management Agency (FEMA) Chemical, Biological, Radiological, and Nuclear (CBRN) office with
- 3 representatives from the Departments of Energy (DOE), Health and Human Services, Homeland Security,
- 4 Defense, and the Environmental Protection Agency (EPA). Future editions and interagency coordination
- 5 related to Planning Guidance for Response to a Nuclear Detonation will be coordinated by FEMA.

- 6 Please refer comments and questions to the FEMA CBRN Office
- 7 (<https://www.fema.gov/about/offices/chemical-biological-radiological-and-nuclear>).

8 Foreword for Third Edition

9 The First Edition of this planning guidance focused on a small nuclear detonation at ground level in an
10 urban environment—specifically National Planning Scenario #1¹. The Second Edition provided updated
11 terminology, added the concept of the Hot Zone (HZ), and added a chapter specifically to address public
12 preparedness and emergency public communications in the post-detonation environment.

13 This third edition has been updated and expanded to provide guidance for a wider range of nuclear
14 detonations, including larger detonations and air bursts, incorporates new research, best practices, and
15 response resources. Additionally, this version of the planning guidance includes a new chapter on the
16 Integrated Public Alert & Warning System (IPAWS), which enables state, local, tribal, and territorial (SLTT)
17 officials to send warnings and key messages during the response.

¹ To access National Planning Scenario #1, visit https://www.fema.gov/txt/media/factsheets/2009/npd_natl_plan_scenario.txt

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59 Acknowledgments

60 The FEMA CBRN Office gratefully acknowledges the guidance and support provided by the Department of
61 Energy (DOE) and the National Labs, the Department of Health and Human Services (HHS), the Centers for
62 Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA), and other FEMA offices.

63 Radiation Units

64 Roentgen, Rad, & Rem

65 This document uses units familiar to U.S. audiences and emergency responders:

- 66 ▪ roentgen (R): The unit of **exposure** associated with gamma or x-rays in air. This is the most common
67 unit of measurement for US emergency response equipment, often expressed in mR. 1,000 milli-
68 roentgen (mR) = 1 roentgen (R).
- 69 ▪ roentgen per hour (R/h): The unit for **exposure rate** associated with gamma or x-rays in air,
70 exposure per unit of time.
- 71 ▪ rad: The unit associated with the **absorbed dose** of ionizing radiation. Absorbed dose is the energy
72 deposited per unit mass of matter (e.g., tissue). The international unit for absorbed dose is the gray
73 [Gy] and the conversion is 1 Gy = 100 rad.
- 74 ▪ rem: The unit that adjusts the absorbed dose for the biological effectiveness of ionizing radiation in
75 tissue to express the long-term risk of cancer (also called dose equivalent). The international unit is
76 the sievert [Sv] and the conversion is 1 Sv = 100 rem.

77 For **external gamma radiation from fallout**, the following approximation can be used:

$$78 \quad 1 R \approx 1 \text{ rad} \approx 1 \text{ rem}$$

79 **Table 1: Radiation Measurement Units**

| | Traditional Units | SI Units |
|-----------------|-------------------|-------------------------|
| Radioactivity | Curie (Ci) | Becquerel (Bq) |
| Absorbed dose | rad | Gray (Gy) |
| Dose equivalent | rem | Sievert (Sv) |
| Exposure | Roentgen (R) | Coulomb/Kilogram (C/kg) |

80 **Table 2: Traditional/SI Unit Conversions**

| | |
|----------------|--|
| 1 Curie | 3.7x10 ¹⁰ Becquerel (Bq)= 3.7x10 ¹⁰ disintegrations/second |
| 1 rad | 0.01 Gray (Gy) or 1 centiGray (cGy) |
| 1 rem | 0.01 Sieverts (Sv) |
| 1 Roentgen (R) | 0.000258 Coulomb/kilogram (C/kg) |

| | |
|----------------|---|
| 1 Curie | 3.7×10^{10} Becquerel (Bq) = 3.7×10^{10} disintegrations/second |
| 1 Gray (Gy) | 100 rad |
| 1 Sievert (Sv) | 100 rem |

81 Structure of this Document

82 For planners with specific specialties or authorities, Chapters 3 through 7 are each designed to be pulled
83 out and, when combined with Chapters 1 and 2, form stand-alone guidance documents. For example, if a
84 planner is only responsible for early medical care, covered by Chapter 4, they would only need Chapters 1,
85 2, and 4.

86 In each section and chapter, key opportunities to act, coordinate with other governments or agencies,
87 reference external materials, and think critically are highlighted. These opportunities take one of four
88 forms, described below:



89 Action Item

90 A suggested activity for the planner to complete.



91 Coordination Opportunity

92 An interagency or interorganizational coordination opportunity. Making these connections during
93 planning can simplify coordination during response.



94 Refer To

95 References to additional information in separate resources.



96 What Would You Do?

97 A critical thinking exercise or discussion question. These questions highlight unique aspects of
98 nuclear response.

99 Acronyms and definitions for terms used in this guidance can be found at the back of the guidance.

100 Introduction

101 If a nuclear detonation occurred in an American city, it would be one of the most catastrophic incidents the
102 United States (US) has ever experienced. Responders must be prepared to address the unique challenges
103 of a nuclear response. With careful planning, many— if not most— lives can be saved. Additionally,
104 preparing and planning for nuclear detonations better equips your community for other natural and man-
105 made hazards/disasters, such as fire-spread, hurricanes, earthquakes, and radiological incidents.

106 While the fallout hazard is unique, most aspects of multi-hazard or all-hazard planning and response are
107 applicable to nuclear detonation response and planning. Planners and responders bring a wealth of
108 experience and expertise to nuclear detonation response. This guidance provides nuclear detonation
109 information and context to enable planners, responders, and their leaders to leverage their existing
110 capabilities.

111 This document describes the considerations, planning factors, and available resources to craft a
112 successful nuclear detonation response plan. The focus of this document is on the first 24 to 72 hours
113 after a detonation, when early actions can save many lives.

114 The primary audiences for this planning guidance are Federal, state, local, tribal, and territorial (FSLTT)
115 emergency response planners, at all levels, and their leadership. The target audiences for this document
116 include, but are not limited to:

- 117 ▪ Emergency managers
- 118 ▪ Law enforcement authority planners
- 119 ▪ Fire response planners
- 120 ▪ Emergency medical service planners
- 121 ▪ Hazardous material (HAZMAT) response planners
- 122 ▪ Utility service and public works emergency planners
- 123 ▪ Transportation planners
- 124 ▪ Public health planners
- 125 ▪ Medical provider planners (e.g., hospitals)
- 126 ▪ Mass care providers (e.g., American Red Cross)
- 127 ▪ Public Information Officers (PIOs)
- 128 ▪ Local & regional private sector industries capable of providing logistical support for the immediate
129 response—either by voluntary actions or by requisition of resources.

- 130 ▪ Other emergency planners, planning organizations, and professional organizations that represent
131 disciplines that conduct emergency response activities.

132 This guidance was developed by a Federal interagency writing team led by the FEMA CBRN Office. The
133 guidance could not have been completed without the technical assistance provided by agencies and
134 organizations summarized in the Acknowledgements section. This planning guidance underwent extensive
135 stakeholder review, including Federal interagency and [national laboratory](#) subject-matter experts;
136 emergency response community representatives from police, fire, emergency medical services; medical
137 providers; and professional organizations, such as the Health Physics Society and the Interagency Board.

138 This guidance also reflects evolving nuclear threats. The 2010 Planning Guidance focused on 10 kiloton
139 (kT) and smaller-yield detonations consistent with the threat of nuclear terrorism, all occurring at the
140 Earth’s surface. This 2021 Planning Guidance update addresses an expanded range of threat scenarios,
141 including nation-state threats² with much larger explosive yields. Guidance also considers nuclear devices
142 delivered by ballistic missile or aircraft which can deliver detonations elevated in the air. Air bursts can
143 increase the scale of the blast and thermal damage inflicted and may also significantly reduce the fallout
144 produced. Urban emergency planners should focus on surface and low-altitude detonations because these
145 detonations will have the greatest effect on the urban environment.

146 The technical community that developed Chapter 1 and Chapter 2 of this guidance was tasked to address
147 how these expanded threat factors shape the resulting guidance for emergency response planning.

² Nation-state threats are threats from other countries or ‘nation states’. As countries are typically larger, more organized, and better funded than non-state groups, the threats from these countries are generally more sophisticated.

148 **Critical Considerations**

149 No significant federal response will be at the scene for 24 hours and the full extent of federal assets will not
150 be available for several days. Emergency response is principally a local function. Federal assistance will be
151 mobilized as rapidly as possible; however, for purposes of this document, no significant federal response
152 beyond coordination or modeling is assumed for 24-72 hours.

153 Based on technical analyses and modeling, recommendations are intentionally simplified to maximize
154 their utility in uncertain situations where technical information is limited.

155 While fallout will reach across many jurisdictions, potentially multiple states, this guidance is intended
156 primarily for those in the physically damaged areas and areas where radioactive fallout is life-
157 threatening.

158 Narrative

159 This Narrative is a fictional depiction of how a nuclear detonation might unfold in a modern United States
160 city. The intention is to emphasize that preparedness is achievable and can save many lives.

161 *Fire Chief Sophia, Fire Station 52, Moderate Damage Zone (MDZ) 2 Miles from Metropolis City Center,*
162 *9:00AM (T + 0 min)*

163 The flash completely blinded Sophia as she drove out of the firehouse after her shift— her entire field of
164 vision was bright white. She quickly braked and heard other vehicles doing the same. Still, her car lurched
165 to the left with the sound of a low-speed impact.

166 Her hands, neck, and face felt like they were on fire, and she ducked below the dashboard instinctively.
167 Just as her vision started to return, she heard an overwhelming sound, her windows cracked, and her car
168 lurched again.

169 *Emergency Planner Jayden, City Emergency Operations Center (EOC), Light Damage Zone (LDZ) 10 miles*
170 *from Metropolis, 9:00AM (T + 0 min)*

171 Metropolis’s watch center was a small, windowless room on the third floor of the City Emergency
172 Management Agency building. Dozens of television screens illuminated the walls, and the chatter of first-
173 responder radio broadcasts saturated the air.

174 Suddenly, the lights flickered, the televisions went to static, and the radio chatter went silent. Seconds
175 later, the televisions and radios came back, with loud exclamations: “Do you see that?” and “That is
176 BRIGHT”.

177 “Get City Hall on the phone and find out what’s going on— I’m calling the state EOC” Jayden heard the
178 watch center supervisor order. Equipment lacking back-up power briefly went dead before emergency
179 generators kicked in for essential systems. Almost a minute after the initial disturbance, the entire room
180 suddenly shook, as if a truck had slammed into the building.

181 “I’m going to take a look outside,” Jayden announced to the room. As Jayden ran down the hall, he noticed
182 confused co-workers peering out partially shattered windows. Stepping out onto the balcony, Jayden saw a
183 massive column of smoke rising over the horizon above Metropolis.

184  Refer To

185 *Chapter 1: Nuclear Detonation Impacts* for information about immediate impacts, such as flash
186 blindness and electronic equipment effects.

187 ***Fire Chief Sophia, Fire Station 52, MDZ 2 Miles from Metropolis, 9:05AM (T + 5 min)***

188 After about a minute, the fire chief’s vision and hearing had mostly returned. Seeing no immediate danger,
189 she stumbled to check on the other driver and confirmed he was okay. Looking around, the chief was
190 confused—her vehicle was not on fire, but she had felt like she was getting burned moments ago.

191 A large cloud hung over the city center, but it looked strange— way too big to move that fast. It was red,
192 black, and brown but unlike the fire smoke plumes she was familiar with. Piecing together the information,
193 she suddenly understood and ran back to the firehouse.

194 When she arrived, the station’s backup lights were on. She attempted to call dispatch, but the land line
195 was dead and her cellphone had no signal. She could hear chatter through her 800 MHz radio about a
196 nuclear detonation and tried to respond with her shoulder mic, but the radio failed to transmit. She
197 restarted the radio and tried again, “This is the Chief from Station 52. We can hear you,” she successfully
198 transmitted. “We’re assuming this was a nuclear detonation and operating according to our protocol: We’re
199 sheltering at the station, monitoring radiation levels with our detection equipment, avoiding outdoor
200 operations unless exposure rates are below 10 mR/hr, and updating the city’s EOC with our status every
201 30 minutes. Be advised, roadways in our area are impassable due to a traffic jam caused by blinded
202 drivers.”

203 The fire chief knew that there were two immediate hazards after a nuclear detonation— fallout and fire. The
204 best protection from fallout is to shelter, but the best strategy for evolving fires is to evacuate. A white cloud
205 top would indicate minimal fallout, but a dark cloud, like the one she saw, likely means significant fallout
206 levels. Her fears were confirmed as radio chatter indicated that firehouses on the other side of town were
207 seeing high radiation levels.

208 ***Emergency Planner Jayden, LDZ City EOC, 10 miles from Metropolis, 9:05AM (T + 5 min)***

209 After Jayden returned to the watch center and explained what he saw, his supervisor announced, “Per our
210 public warning protocols, if we suspect a nuclear detonation, we must immediately distribute a shelter-in-
211 place (SIP) warning. We have the pre-scripted message ready to send to every cellphone, radio, and news
212 station within 50 miles of Metropolis, but we need sign-off from the front office. Unfortunately, city and
213 county leadership were at the event downtown, and neither are answering the phone.”

214 The agency’s Public Information Officer (PIO), responded, “The protocol allows flexibility if agency
215 executives are unavailable—you and I can sign-off. We have to do this now.”

216



Refer To

217

Chapter 6: Communications for information about developing message dissemination plans.

218 Leveraging FEMA’s Integrated Public Alert & Warning System (IPAWS) network, as well as the city’s own opt-
219 in emergency communication service, the watch office distributed an emergency shelter-in-place message
220 to everyone within 50 miles of Metropolis. The Wireless Emergency Alert (WEA) message, distributed to
221 cellphones, read: “This is a message from Metropolis Emergency Management Agency: a nuclear

222 detonation has occurred. To protect yourself and your family, get inside, stay inside, stay tuned for more
223 information. Follow instruction from officials—this can save your life.”



224

225 **Figure 1: WEA message on a cellphone that reads “This is a message from Metropolis Emergency**
226 **Management Agency: a nuclear detonation has occurred. To protect yourself and your family,**
227 **get inside, stay inside, stay tuned for more information. Follow instruction from officials—this**
228 **can save your life.”**

229 Over the next few minutes, several more WEA messages came through— but not from the City Watch Office.
230 Two came from neighboring counties, one from the State EOC, and yet another from the White House. Every
231 message said the same thing: “Get Inside, Stay Inside, Stay Tuned.”

232



Refer To

233 *Chapter 7: Public Preparedness: Alerts, Warnings, Notifications and FEMA’s Integrated Public Alert*
234 *and Warning System (IPAWS) for information about IPAWS and WEA messaging.*

235 ***PIO Jose, State Joint Information Center (JIC), 50 miles from Metropolis, 9:15AM (T + 15 min)***

236 Jose’s phone buzzed when he received the emergency alert from Metropolis’ EOC. The State EOC was
237 officially sheltering-in-place since they were just 50 miles from Metropolis. Metropolis’ watch center
238 messages made it out just before the State JIC stood up, but the message was aligned with the JIC plan
239 because they were using the same communication plan and preapproved messages.

240 Jose immediately initiated the phone tree to mobilize his PIO staff. He immediately sent the draft message:
241 “A nuclear detonation has occurred in Metropolis. Everyone—including responders—within 50 miles of
242 Metropolis, must immediately get underground or inside the innermost room of a sturdy building. Stay
243 there for 24 hours, unless you are told to leave, have a medical emergency, or your shelter is threatened by
244 fire or collapse.”

245 Jose quickly checked his email and saw a message from the Lieutenant Governor: “FEMA confirmed a
246 nuclear detonation in Metropolis.” Jose quickly sent a message to his media contacts confirming the
247 detonation, reminding them to disseminate the “Get Inside, Stay Inside, Stay Tuned” message. He attached
248 the media guide his team had built to answer common safety and technical questions and pressed send.

249 ***Emergency Planner Jayden, City EOC, LDZ 10 miles from Metropolis, 12:00PM (T + 180 min)***

250 Three hours after the detonation, Jayden was staffing the Situation Unit in the City’s EOC. Their task was to
251 receive, aggregate, and map impact reports from the entire City every 30 minutes. Due to limited operating
252 communication infrastructure in the blast area, most information came from facilities that were equipped
253 with radios, like firehouses, police precincts, and hospitals. The internet was too unstable for the EOC to
254 use their online systems, so the Situation Unit resorted to manual entry into offline spreadsheets and
255 geographic information system (GIS) programs.

256 For the time being, radio-only communication was a bottleneck, so the information they collected had to
257 remain simple. It included reports on casualty triage, blast damage, fires, and radiation exposure rates.
258 Occasionally, facilities reported their status and resource needs, and this information was relayed to the
259 appropriate Emergency Support Function (ESF) Coordinator in the EOC.

260 Over time, it became clear that the heaviest damage was in a roughly two-mile-wide area around
261 Metropolis’ City Center. No information was available within a half-a-mile radius. Though rapid fallout decay
262 caused exposure-rate reports to vary significantly, it was very clear that most fallout material settled north
263 of the city.

264 ***Fire Chief Sophia, Fire Station 52, MDZ 2 Miles from Metropolis, 12:25PM (T + 205 min)***

265 Radiation readings outside were elevated at a few milliroentgen per hour (mR/hr), but well below the 10
266 R/hr that would require Sophia’s crew to remain sheltered. Station 52 was south of the detonation, and
267 since the City EOC reported that fallout went north, Sophia knew she was able to act.

268 People with injuries had been arriving at the firehouse since the explosion, mostly with non-life-threatening
269 injuries, like cuts and bruises from flying/falling glass and debris. Sophia put her paramedic in charge of
270 setting up a casualty collection point and moving casualties to the care center at the hospital a few miles
271 south.

272 Using her rig to clear a path, Sophia took the rest of her crew northward, keeping an eye out for fires.
273 Eventually the road became impassable, and she left the rig near a hydrant and put down lines for fire
274 defense to aid affected people and establish an evacuation corridor.

275



Refer To

276 *Chapter 4: Early Medical Care* for information about likely casualties and how to triage and treat
277 various injuries

278 Her crew made headway into the MDZ until she could see almost complete destruction ahead and
279 radiation levels approached dangerous levels. She knew that ahead lay the severe damage zone (SDZ),
280 where her crew would not be able to safely enter, and the possibility of viable survivors was low.

281



Refer To

282

Chapter 2: A Zoned Approach for information about various zones, including the MDZ and SDZ

283

She could see several fires but did not have the resources to put them all out. She ordered her crew to prevent fire spread when possible and protect the evacuation corridor they had established.

284

285

She knew the buildings around her were probably filled with sheltered people, many of whom were likely injured by the blast. She did not have the time or resources to perform building by building search and rescue operations, and fires were spreading and coalescing in the area. She raised her bullhorn and said “This is Metropolis Fire Department— if you can hear this, please proceed toward the sound of my voice. This area is not safe, and you must evacuate.”

286

287

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289

290



Refer To

291

Chapter 3: Shelter & Evacuation Guidance for information about sheltering and evacuating various populations

292

293

Emergency Planner Jayden, City EOC, LDZ 10 miles from Metropolis, 1:00PM (T + 240 min)

294

Jayden received communication from the State EOC that FEMA and the state government established a joint Initial Operating Facility (IOF) at a convention center outside the City. The IOF was tasked with developing a common operating picture (COP) of the detonation impacts and emergency response efforts, and the City EOC would be included in the upcoming call.

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The call included representatives from the State EOC, City EOC, FEMA’s Incident Management Assistance Team (IMAT), Interagency Modeling and Atmospheric Assessment Center (IMAAC), and a few neighboring jurisdictions. The State EOC and FEMA staff explained that they had considerable data from federal assets and counties near Metropolis, but almost nothing from the city itself. They were relieved to receive the data the city had been collecting from responders in Metropolis, and immediately began merging it with regional data and IMAAC models.

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Since both the City and State nuclear detonation plans employed the same zone-based response framework, they agreed on a few things immediately. Firstly, no operations would occur in the SDZ. Also, both responders and the public would be urged to continue sheltering indoors if in/near areas where radiation levels were immediately hazardous to health (the Dangerous Radiation Zone (DRZ)). It was clear that life-saving operations, such as search and rescue and medical triage and treatment, would be prioritized in the MDZ, where the majority of severe injuries were being reported. Finally, roadways were blocked and power was out regionally, therefore restoration of critical infrastructure was an immediate priority.

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The state and federal government were still mobilizing to support the city’s response, but adjacent jurisdictions were supporting response efforts by accepting evacuees, providing contamination screenings

313

314 and decontamination, expanding medical care resources, and sending first-response assets. Over the next
315 72 hours, a considerable amount of resources would be arriving from across the nation to support the city
316 and state, but the city itself was primarily responsible for response.



Refer To

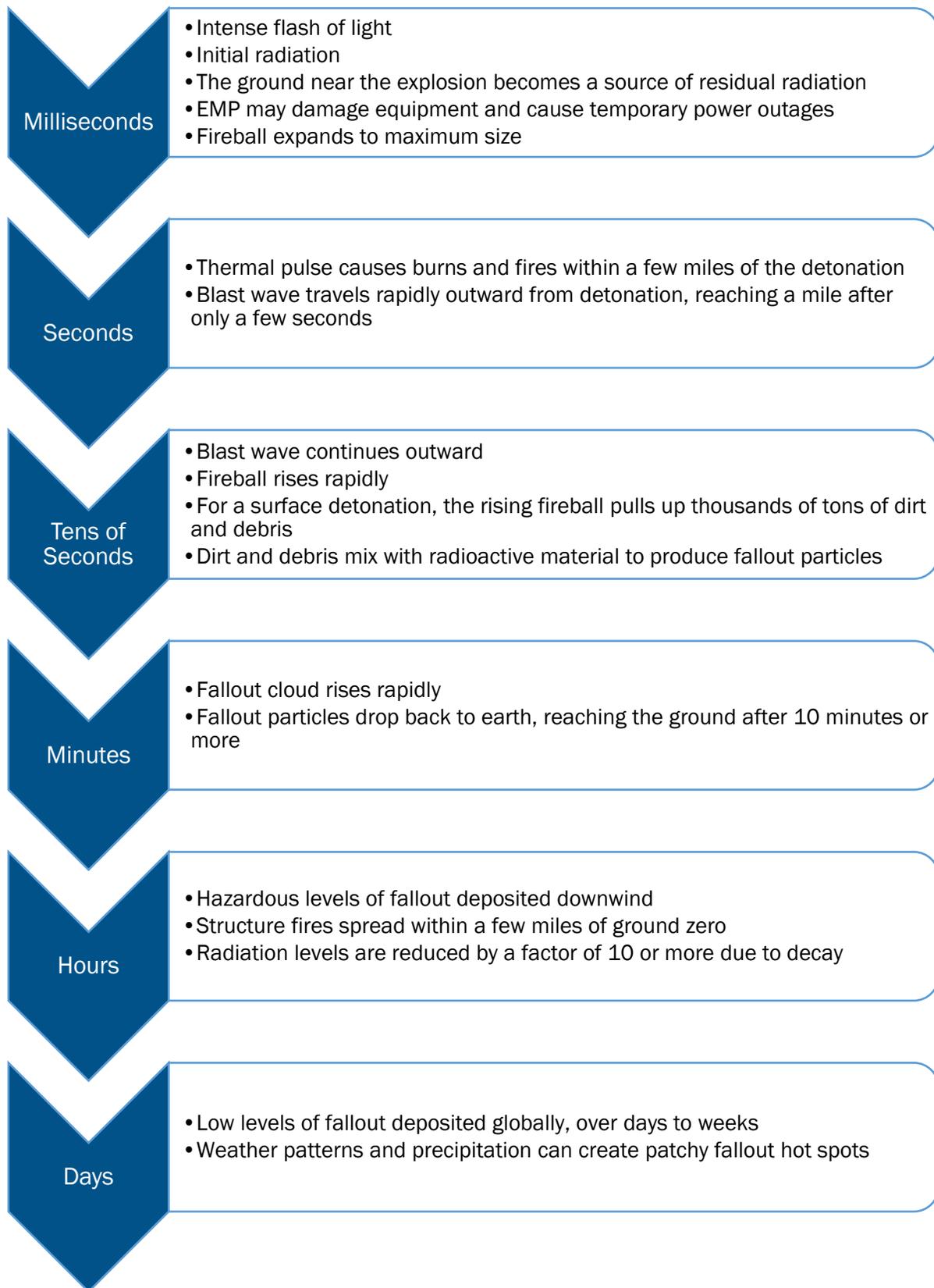
318 *Chapter 5: Contamination Screening, Decontamination, and Long-Term Follow-Up* for information
319 about contamination screening

Chapter 1: Nuclear Detonation Impacts

The descriptions and planning factors provided in this document are nominally based on the Department of Homeland Security (DHS) National Planning Scenario (NPS) #1, which describes a 10 kiloton (kT) yield nuclear detonation at ground level in an urban environment. This document captures a wider range of potential planning considerations, describing the impacts of smaller and larger yields, as well as detonations that occur above ground (see Table 3).

Table 3: Planning Guidance Scenarios

| Yield | Height Above Ground |
|--------|---------------------|
| 0.1 kT | Ground burst |
| 1.0 kT | Ground burst |
| 10 kT | Ground burst |
| 100 kT | Ground burst |
| 100 kT | Air burst, 1000 ft |
| 100 kT | Air burst, 5000 ft |



328

329

Figure 2: Timeline of key effects for a 10 kT surface detonation.

330 Nuclear detonations release intense light, a pulse of heat and radiation, and a blast wave. In many
331 circumstances, additional effects include residual radiation in the form of fallout and an electromagnetic
332 pulse.

333 **What are detonation yields?**

334 Even a small nuclear detonation produces an explosion far surpassing that of conventional explosives.
335 It would take 1,000 tons of TNT to release the same energy created by the fission of all the atoms in
336 just 2 oz. of Uranium.

337 The magnitude, or yield, of a nuclear explosion is quantified in terms of the equivalent amount of TNT
338 (a chemical explosive) it would take to create the same energy release. It is usually in the thousands of
339 tons (kT) of TNT. Therefore a 1 kT nuclear device would produce an explosive yield equivalent to one
340 thousand tons of TNT. For comparison, this is the approximate amount of energy released in the 2020
341 Beirut ammonium nitrate port explosion. (Rigby, 2020)

- 342 ▪ **A brilliant flash of light** occurs at the moment of above ground detonations, causing temporary
343 blindness, called flash blindness or dazzle, up to 10 miles away.
- 344 ▪ **Radiation** is one of the key outputs from a nuclear explosion. Radiation from a nuclear explosion is
345 categorized as either initial radiation, which occurs nearly instantaneously, or residual radiation, which
346 remains after the explosion. Initial radiation occurs within the first minute after a nuclear explosion and
347 contributes to casualties up to about a mile from the detonation. Residual radiation consists of
348 activated materials³ near the detonation location and nuclear fission products⁴ that may produce long
349 range fallout.
- 350 ▪ **An electromagnetic pulse (EMP)** is generated by the initial nuclear radiation. Although not a direct
351 physical hazard, EMPs can disrupt or damage some electronic equipment within a few miles. For low-
352 altitude bursts, the EMP can cause disruptive power surges on power lines within a few miles of the
353 detonation and induce cascading disruptions miles from the detonation site.
- 354 ▪ **The fireball** is a luminous sphere of extremely hot gases (tens of million degrees) which forms a few
355 thousandths of a second after a nuclear explosion. The fireball from a 10 kT detonation will reach
356 approximately ¼ mile in diameter and give off a thermal pulse of intense heat within the first few
357 seconds. The high intensity of the thermal pulse differentiates nuclear from chemical explosions.
- 358 ▪ What follows depends on the height of burst above the ground.

³ The absorption of neutron radiation by soil and other surface material in the immediate vicinity of ground zero creates radioactive material, some of which may be undisturbed by the blast, and some of which may be disturbed by the blast and contribute to radioactive fallout downwind.

⁴ Nuclear fission products are the atomic fragments left after a large atomic nucleus (like uranium) undergoes nuclear fission by splitting into two smaller nuclei that are most often radioactive.

- 359 ○ Near-surface⁵ detonations will sweep up thousands of tons of dirt and debris that will mix with the
360 radioactive products, then ‘fall out’ of the cloud as radioactive **fallout particles**. Fallout can create
361 dangerous radiation levels downwind of the detonation. Sheltering in downwind areas can
362 potentially save hundreds of thousands of people from significant radiation exposure.

- 363 ○ An air burst nuclear detonation decreases the risk of fallout, but increases the severity of the
364 intense thermal pulse, inducing **fires** within a few miles of the detonation. Large urban fires can be
365 a significant threat to survivors in the damage zones and evacuation may be required to save lives
366 in this area.

- 367 ■ The rapidly expanding fireball also generates a **blast wave**. The blast wave moves outward, initially
368 moving faster, then slowing down, to the speed of sound. For those beyond a few miles, there will be
369 several seconds between the flash of light and the arrival of the shockwave. For those even further
370 away, the blast wave can still break windows and take tens of seconds to arrive.



371
372 **Figure 3: While radiation risks can be avoided by sheltering, evacuation may be necessary to**
373 **avoid fire risks—planners and emergency managers must balance these risks.**



375 **Refer To**

376 Videos of nuclear detonations are available here: [https://www.llnl.gov/news/llnl-releases-newly-](https://www.llnl.gov/news/llnl-releases-newly-declassified-test-videos)
377 [declassified-test-videos](https://www.llnl.gov/news/llnl-releases-newly-declassified-test-videos)

⁵ This document defines **near-surface** detonations as those where the fireball interacts with the surface of the earth. This is yield dependent, for example for a 100kt yield this would be 1,000 ft or less above ground level.

378 **1. Blast**

379 A primary effect of a nuclear detonation is the blast wave generated by the rapidly expanding fireball. Blast
380 is often measured by the overpressure⁶ it produces.

381 Near the detonation, overpressure is extremely high (thousands of pounds per square inch (psi)) and
382 expands in all directions from the detonation initially faster than the speed of sound. Beyond a few miles,
383 the blast wave will traverse about a mile every five seconds. This may allow a few seconds for those who
384 observe the flash to take cover and reduce injury from flying debris.

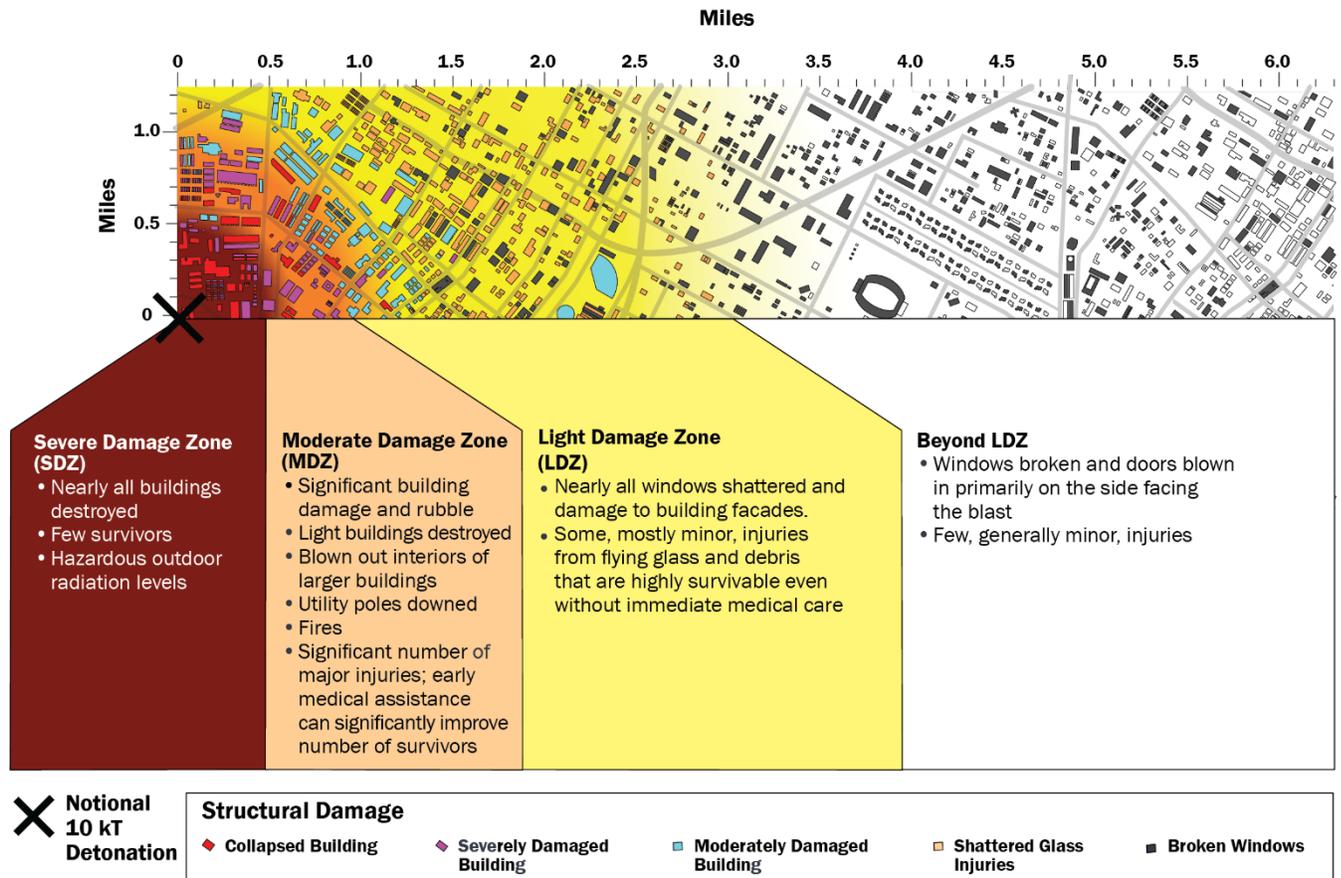
385 **1.1. Damage Zones**

386 Structural damage can be used to describe zones for response planning, where each zone has different
387 response priorities and survival implications. Blast damage mechanisms and the area impacted in each
388 zone vary based on terrain, building density, and atmospheric conditions. As such, **blast damage zones will**
389 **be primarily determined by visual observations of damage.**

390 The purpose of establishing zones is to help planning response operations and prioritizing actions. Models
391 can provide initial zone estimates for planning, though actual zone areas and boundaries will not be as
392 clearly defined as model results imply. Many of the graphics in this document do not have sharp
393 boundaries, to reinforce expected uncertainty and variability. The blast zones depicted below are for a 10
394 kT ground burst nuclear explosion in an urban environment.⁷

⁶ Pressure over and above atmospheric pressure, measured in pounds per square inch (psi).

⁷ Figure 4 assumes a nominal 10 kT surface detonation in a modern city. While distances would vary, the zone descriptions apply to any size nuclear explosion.



395

396

Figure 4: Blast damage zones, including observable features.

397 In the **Severe Damage Zone (SDZ)**, few buildings will be structurally sound or standing. Very few people are
 398 expected to survive in the SDZ. Rubble in streets will be impassable and there will probably be dangerous
 399 radiation levels outdoors, due to residual radiation from the detonation. As an example, the SDZ from a 10
 400 kT surface detonation would extend out about 0.5 miles.

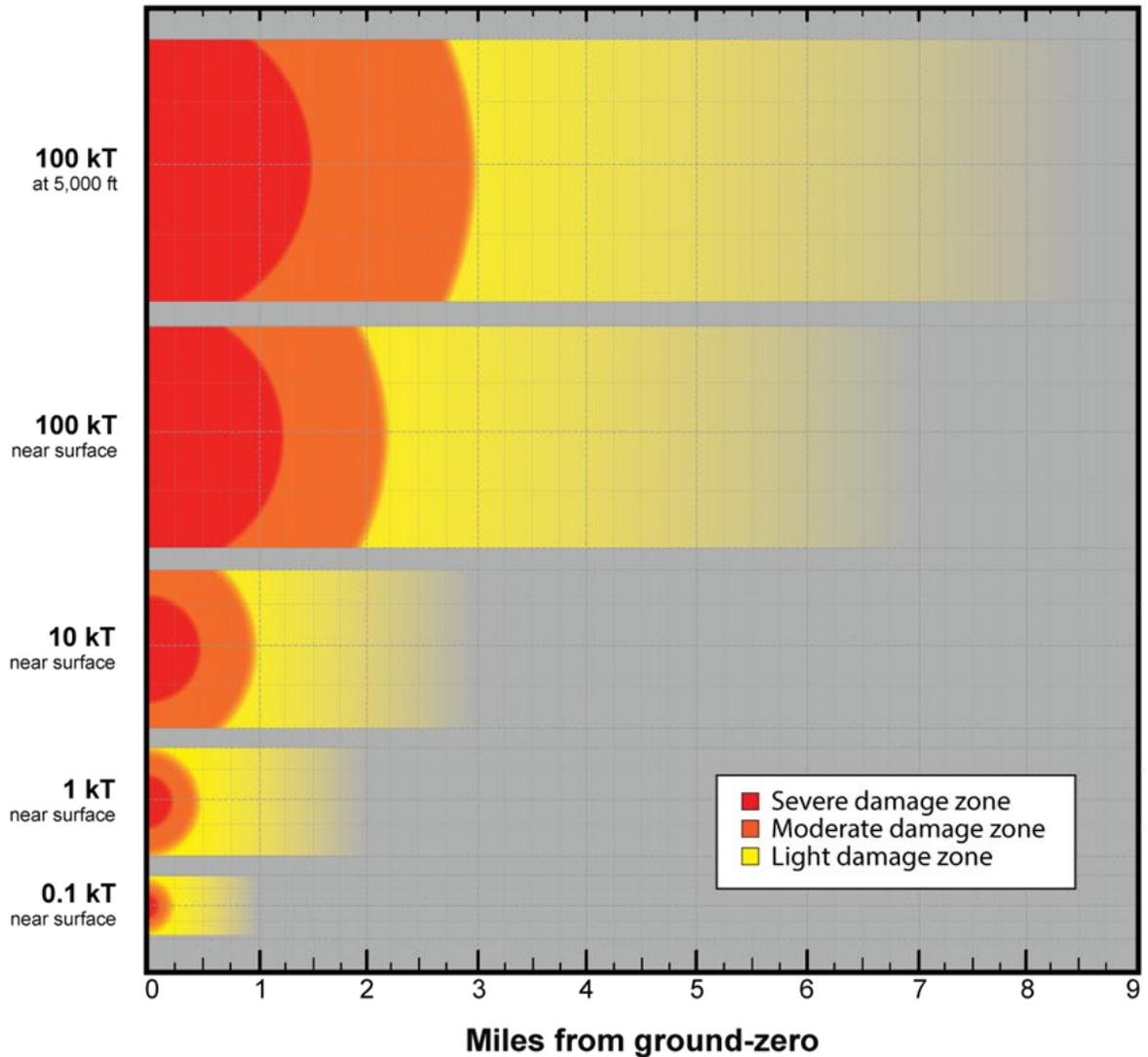
401 Within the SDZ, individuals inside large structures (e.g., subterranean parking garages or subway tunnels)
 402 at the time of the explosion may survive. Survivors should continue to shelter if safe to do so due to
 403 hazardous outdoor radiation levels for the first 24 hours.

404 In the **Moderate Damage Zone (MDZ)**, building damage is substantial. The blast wave briefly creates
 405 instantaneous winds greater than 100 mph, radiating outward from the detonation then reversing direction
 406 to fill the vacuum left by the explosion. There will be significant structural damage within the MDZ,
 407 including blown out building interiors, blown down utility lines, overturned automobiles, caved roofs, some
 408 collapsed buildings, and fires. Telephone and streetlight poles may be blown over. In the MDZ, sturdier
 409 buildings (e.g., reinforced concrete) will remain standing, but lighter commercial and residential buildings
 410 may fall or become structurally unstable, and most wood frame houses will be destroyed. As an example,
 411 the MDZ would extend from about 0.5 mile to 1 mile from ground zero for a 10 kT nuclear explosion at
 412 ground level.

413 Blast damage may generate fires and expose fuel sources (gas line breaks, wood, etc.), potentially causing
414 threatening mass fires and firestorms. Consequently, the MDZ should be an evacuation priority as soon as
415 it is safe to do so (see Chapter 2 for more information).

416 In the **Light Damage Zone (LDZ)**, most damage is caused by the powerful shockwave, like that of a
417 thunderclap, but with substantially more force. Most windows in the LDZ will break, many with enough
418 force to cause injuries from flying glass and debris. Damage in this area will vary as shock waves rebound
419 off buildings, terrain, and the atmosphere. As an example, the LDZ would extend from about 1 to 3 miles
420 from ground zero for a 10 kT nuclear explosion at ground level.

421 Beyond the LDZ, windows facing the blast may be broken for many miles, but there will be significantly
422 fewer injuries.



423

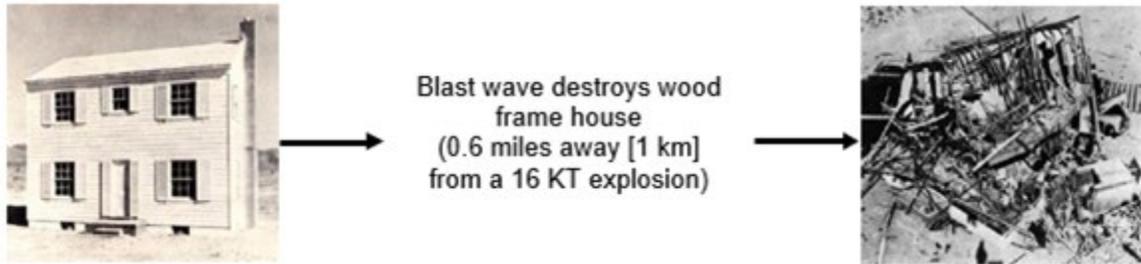
424 **Figure 5: This figure exhibits theoretical damage zones side-by-side, comparing projected zones**
 425 **for 100 kT air detonations and for 100, 10, 1, and 0.1 kT near-surface detonations⁸. For every**
 426 **factor of ten yield increase, the effect ranges typically only increase by a factor of two. For**
 427 **example, the MDZ for 0.1, 1, 10, and 100 kT near-surface detonations extend out a ¼ mile, ½**
 428 **mile, 1 mile, and 2 ¼ miles, respectively.**

429 **1.2. Blast Injuries**

430 In the urban environment, overpressure injuries, such as lung and eardrum damage, will likely be
 431 overshadowed by injuries incurred by collapsing structures and flying debris. In the SDZ and MDZ, many of
 432 these injuries will be fatal. Beyond the MDZ, flying debris injuries will be the most common.

⁸ In the case of 100kT, near-surface applies to both surface detonations and detonations 1,000 ft above ground.

433 In the MDZ, blast wave overpressures can produce flying debris and glass fragments with sufficient velocity
434 to cause blunt trauma and deep lacerations. In the LDZ, windows may break with enough force to injure
435 those standing directly behind them. Many windows will break even beyond the LDZ, but they are unlikely
436 to produce injuries.



437

438 **Figure 6: Blast wave effects on a house in the SDZ indicate low likelihood of survival in**
439 **aboveground areas.⁹**

440 If there is advanced warning of a nuclear detonation, sheltering in the middle or basement of the
441 nearest large building can prevent many blast, radiation, and thermal casualties.

442 For nuclear detonations without warning, many casualties can be avoided if individuals that see the
443 intense and unexpected flash of light immediately seek cover. The flash can precede the blast wave by
444 seconds, creating a short window for those in the blast zones to get away from windows and take
445 cover.

446 There will be many significant injuries in the MDZ, requiring urgent medical care to save lives.

447 2. Prompt Thermal Effects and Fire

448 Unlike other explosive incidents, nuclear detonations generate an intense thermal pulse of energy (the
449 nuclear flash). Thermal effects can extend beyond the MDZ for higher yield air burst detonations, resulting
450 in flash blindness, burns injuries, and fires.

451 2.1. Nuclear Induced Fires

452 Nuclear induced fires in modern cities are not well understood and remain a major concern. The initial
453 thermal pulse will start fires by igniting flammable materials. Subsequently, initial fires may induce
454 secondary fires by igniting gas from broken gas lines and ruptured fuel tanks.

455 These initial and secondary fires may spread beyond the MDZ, depending on the weather and terrain.
456 These fires may destroy infrastructure and threaten survivors and responders, including those actively
457 sheltering or evacuating. If fires grow and coalesce, uncontrollable firestorms may develop; however,
458 modern U.S. city design and construction make firestorms unlikely.

⁹ This image is derived from Glasstone and Dolan, *The Effects of Nuclear Weapons*, figures 5.55 and 5.57.

459 Nuclear detonation induced fires represent a major hazard, especially in the MDZ, where rapid
460 evacuation may be required. Smoke may be present, complicating the response and posing an
461 additional hazard.

462 The SDZ is not conducive to fires because of the intense winds and flammable sources are buried in deep
463 rubble; however, leaking gas lines may still ignite. In residential areas comprised of wooden houses,
464 significant fire activity may occur. The MDZ is more likely to sustain fires because many buildings will
465 remain standing, while infrastructure damage, like broken windows, gas lines, and fuel tanks, is still
466 extensive.

467 Depending on the material and its distance from ground zero, blast winds can extinguish or fan flames.
468 Weather conditions (primarily wind and humidity levels) also influence fires, potentially causing them to
469 spread quickly and over-run neighborhoods. Fires co-located with blast damage will affect access and
470 response infrastructure, generating a fire hazard that is likely beyond anything that urban emergency
471 management agencies have ever had to manage.



Coordination Opportunity

472
473 Planners should meet with their local and regional fire departments to discuss potential strategies
474 for containing and mitigating fire spread in post-detonation conditions.

475 2.2. Thermal Injuries

476 Thermal radiation emitted by nuclear detonations causes burns in two ways – direct absorption of thermal
477 energy through exposed surfaces or indirectly, from fires ignited by the burst.

478 2.3. Flash Burns

479 Near the fireball, initial thermal energy is so intense that it will incinerate most objects. Lethal distance
480 varies depending on yield, height of burst, line of sight with respect to the fireball, clothing, weather, terrain,
481 buildings, and how quickly victims receive medical care. Thermal energy from the burst causes visible burn
482 patterns on skin surfaces facing the fireball. Urban environments may provide substantial shadowing and
483 reduce overall flash burn impact. However, people with a line of sight to the nuclear fireball may be subject
484 to burn injuries up to a few miles away. The incidence and range of burns will increase with yield and
485 height of burst. See Figure 26, in Chapter 4, for examples of flash burns.

486 2.4. Flame Burns

487 Fires will likely be prevalent in the MDZ, resulting in fatalities and injuries from flame burns and smoke
488 inhalation. Treatment of thermal burns can be compounded by other injuries and radiation dose
489 associated with a nuclear explosion.

3. Eye Injuries

In addition to eye injuries from flying glass and debris, observing the fireball at the moment of detonation can result in temporary or permanent eye injuries. Observing the flash of intense light can cause temporary flash blindness, even when observers are not looking directly at the detonation. Flash blindness may occur over 10 miles from a detonation in daylight, and even further at night. In the daylight, flash blindness can last several seconds, and at night, when pupils are fully dilated, flash blindness may last 5-10 minutes. Flash blindness may be followed by a darkened after image that lasts several minutes. Flash blindness will likely result in traffic accidents and blocked roads far from the damage zones.

The intense visible light that occurs is one of the hallmarks of a nuclear explosion and can often be seen from hundreds of miles away. Sudden exposure to such high-intensity sources of light can cause temporary blindness.

Temporary flash blindness, or dazzle, can occur over 10 miles away (farther if the detonation occurs at night) and can result in blocked roadways due to car accidents.

Although much less common, retinal burns can occur if the intense fireball is in view at the instant of detonation. Retinal burns can result in permanent scarring, loss of visual acuity, and blind spots. This effect can occur several miles from the blast, and roughly double that range at night.



What Would You Do?

What type of guidance would you provide for flash-blinded/visually impaired individuals who need to evacuate?

4. Initial and Residual Radiation

4.1. Initial Radiation

Radiation from nuclear explosions is categorized as either initial nuclear radiation, which occurs within the first minute, or residual radiation, which continues after the explosion. Initial nuclear radiation intensity decreases rapidly with distance from ground zero and initial radiation casualties will likely be minimal beyond about a mile from ground zero.

Buildings and objects attenuate initial radiation, but even dense materials, like steel, do not absorb all the radiation near the detonation. Even if an individual is shielded behind buildings, they may receive an initial radiation dose.

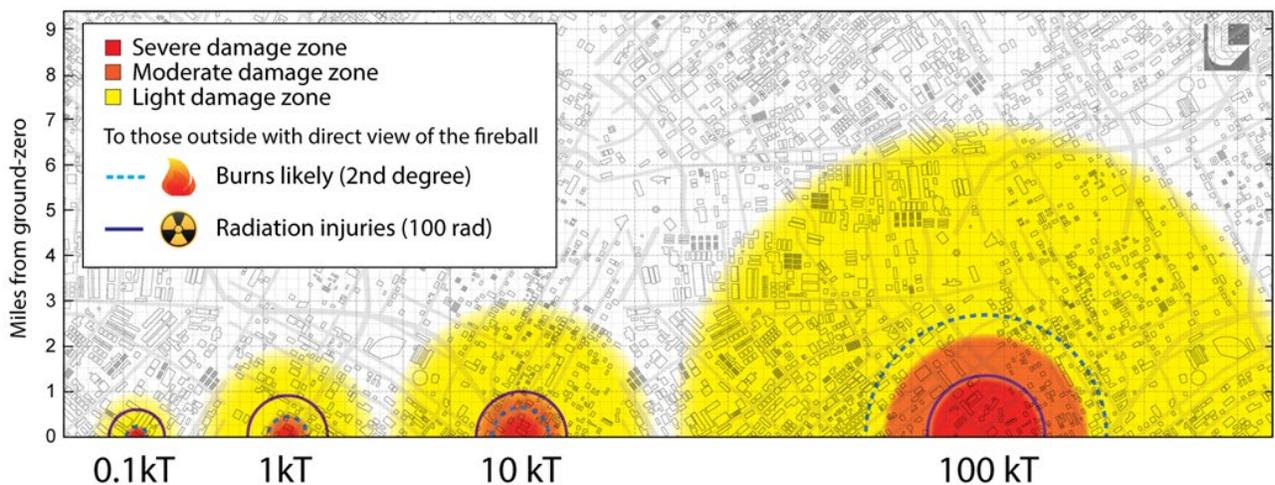
Acute radiation doses are large doses that occur over a short period of time (seconds to days). These doses may cause short-term illness, including life-threatening effects. Some regions with significant blast and thermal damage may also have significant acute radiation doses. Survivors in these areas may suffer from

521 radiation injury combined with blast and/or thermal injuries and should be triaged appropriately (see
522 Chapter 4).

523  Refer To

524 *The Effects of Nuclear Weapons:* [https://www.dtra.mil/Portals/61/Documents/NTPR/4-](https://www.dtra.mil/Portals/61/Documents/NTPR/4-Rad_Exp_Rpts/36_The_Effects_of_Nuclear_Weapons.pdf)
525 [Rad_Exp_Rpts/36_The_Effects_of_Nuclear_Weapons.pdf](https://www.dtra.mil/Portals/61/Documents/NTPR/4-Rad_Exp_Rpts/36_The_Effects_of_Nuclear_Weapons.pdf)

526 Below, Figure 7 compares the area where unobstructed initial radiation may cause illness to those
527 outdoors (1 Gy or 100 rad); as well as the area where thermal effects may cause 2nd degree burns. These
528 areas are overlaid on damage zones for 0.1, 1, 10, and 100 kT surface detonations. Notice how initial
529 radiation and thermal effects do not scale with blast effects. Initial radiation becomes a more dominant
530 hazard for low yields, while the range of thermal effects becomes more prominent at higher yields.



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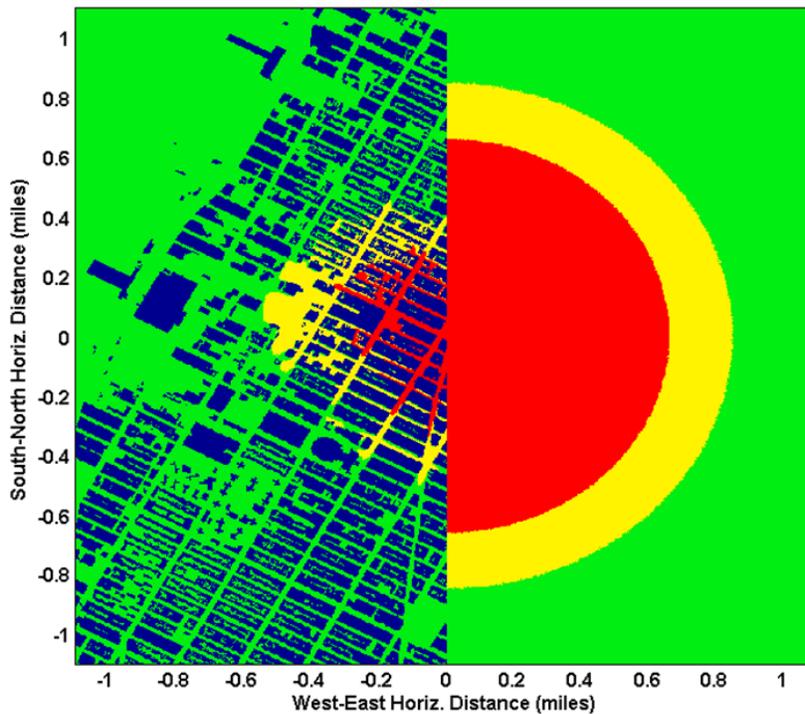
532 **Figure 7: Radiation and burn injury ranges overlaid on damage zones demonstrating the extent of**
533 **outdoor 1 Gy (100 rad) initial radiation and 2nd degree thermal burns for unobstructed 0.1, 1,**
534 **10, and 100kT surface detonations.**

535 Initial radiation induced injuries can occur within a mile of a nuclear detonation.

536 4.1.1. INITIAL RADIATION VARIABILITY

537 Figure 8 compares initial radiation exposure outdoors in an open field environment (on the right), to initial
538 radiation exposure outdoors in a dense urban environment (on the left). This comparison highlights the stark
539 contrast between open spaces and urban areas, where building shadowing and attenuation effects are
540 considered. The attenuation effects shown are less dramatic in air burst scenarios, smaller cities, and lower
541 density cities.

542 While the range of initial outdoor radiation will be reduced for surface detonations in urban
543 environments, air burst induced radiation would not be as significantly reduced.



544

545 **Figure 8: Outdoor initial radiation exposure levels for a dense urban area (left) and for a flat**
546 **concrete slab (right) from a 10 kT surface level detonation; red >8 Gy (>800 rad) (lethal),**
547 **yellow 1-8 Gy (100-800 rad) (injurious to lethal), green < 1 Gy (<100 rad) (below an acute**
548 **injury) (courtesy of Kramer, 2014).**

549 **4.2. Residual Radiation**

550 In addition to initial radiation during the detonation, the explosion also generates residual radiation that
551 continues after the explosion. Residual radiation is emitted by two types of radioactive contamination: (1)
552 activation products and (2) fission products.

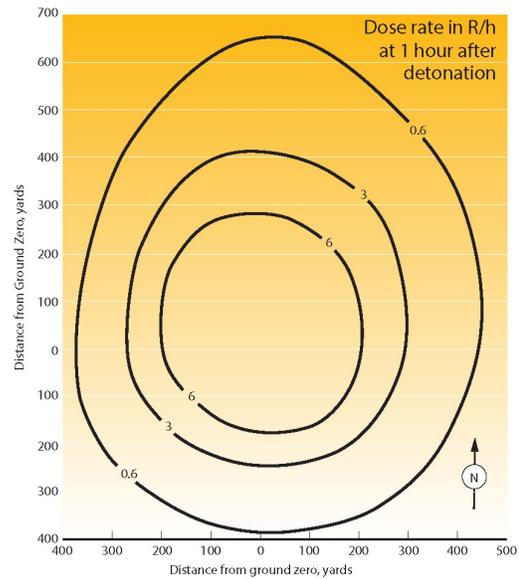
553 **Activation products** are formed when radiation from the explosion interacts with surrounding materials
554 (e.g., air, ground, buildings, and man-made objects) making them radioactive. Subsequently, these
555 radioactive materials emit residual radiation as they decay.

556 Activation products can remain on the ground or be swept into the air, becoming part of the fallout cloud.
557 Activation products may continue to produce residual radiation depending on the materials present,
558 weapon design, and height of burst. When detonations occur at sufficiently high altitudes, there is no
559 substantial local fallout (though initial radiation can activate the ground near the detonation). An example
560 activation area from a nuclear test can be seen in Figure 9.

561



Baker (Buster-Jangle) 3.5 kt @ 1118 ft



562

563

564

565

Figure 9: Residual radiation from activation products after the (Buster-Jangle) Baker shot at the Nevada Test Site (NTS) (now known as the Nevada National Security Site). Exposure rates are 1 hour after detonation.

566

Despite causing minimal fallout (due to the height of explosion), both Hiroshima and Nagasaki

567

detonations produced a Hot Zone (HZ)¹⁰ at ground zero that lasted about 5 days.

568

Fission products are the radioactive material created when uranium or plutonium nuclei split apart and represent most of the radioactivity in fallout. In contrast to radiation released from a nuclear power plant (NPP) incident, most of the fission products released from a nuclear detonation are short-lived and are most hazardous in the first few hours to days after the detonation.

569

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Fission products are vaporized in the fireball and are retained within the resulting nuclear cloud. Due to the extreme heat of the fireball, the nuclear cloud rises rapidly, often several miles into the atmosphere. For near-surface detonations, the strong updraft below the cloud can result in the incorporation of thousands of tons of dirt and debris (see Figure 11). The highly radioactive fission products coalesce on the dirt and debris pulled into the cloud and the resulting particles (i.e., ‘fallout’) will be of varying sizes—some are so small they cannot be seen by the naked eye, while others can be as large as pebbles.

573

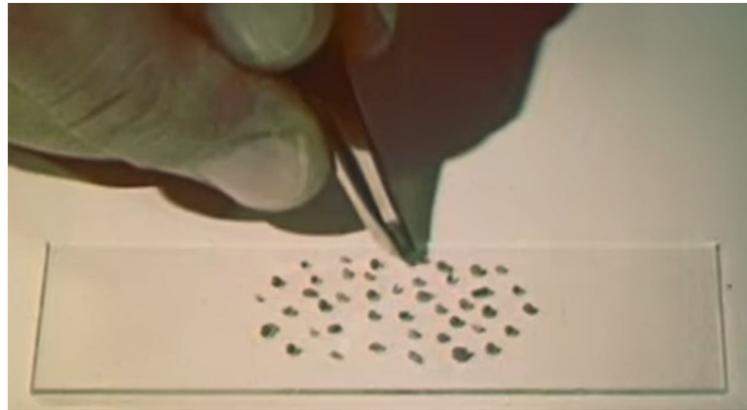
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¹⁰ The Hot Zone is an area where radiation levels exceed 10 mR/h and additional controls are warranted to reduce exposure. For more information, see the Hot Zone section.



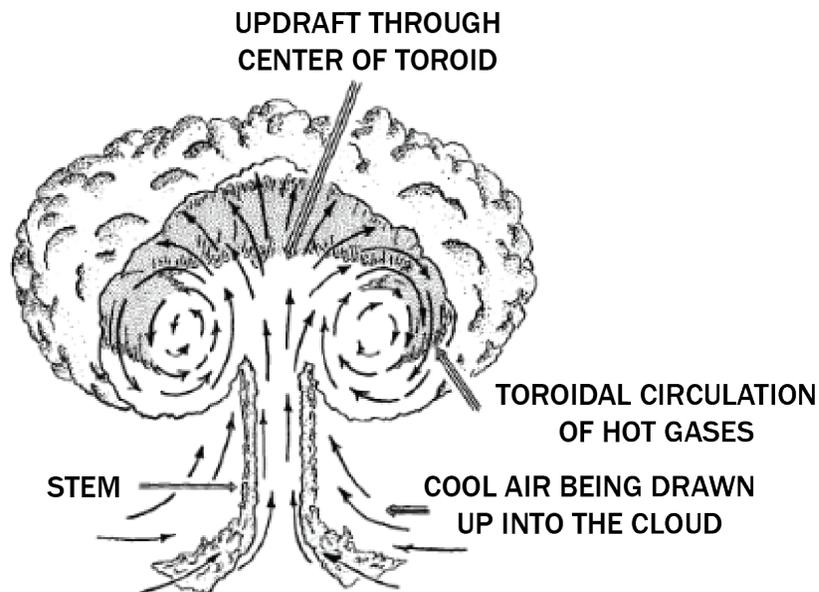
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Figure 10: Fallout particles from nuclear tests.

580 After a nuclear detonation near the surface, immediately dangerous fallout will descend back to earth
581 within the first few minutes to hours and can be readily visible as it comes down.

582 The larger particles tend to fall closer to the detonation site within the first couple of hours, whereas the
583 small particles tend to stay in the atmosphere for much longer, perhaps for days or weeks. Although details
584 are highly dependent on weather conditions, the most dangerous concentrations of fallout particles
585 deposit during the first few hours and are clearly visible as they fall, often being the size of fine sand or
586 table salt.



587

588 **Figure 11: Example mushroom shaped cloud from a near-surface nuclear detonation (derived**
589 **from Glasstone and Dolan, 1977).¹¹**

¹¹ Toroidal refers to the donut-like shape in mushroom cap of the cloud. The donut shape is called a torus.

590

591 The direction of the fallout depends on the height of the cloud, because windspeed and direction vary at
592 different altitudes. The nuclear cloud and the descending fallout material are pushed by the winds in a
593 direction that may not be evident from ground-level wind observations and may not accurately predict the
594 path of fallout deposition.

595 Appropriate radiation monitoring is necessary to determine an area's safety. Besides dry deposition caused
596 by gravity, radioactive particles in the nuclear cloud can also be brought to the ground by precipitation such
597 as rain or snow, producing a local radiation hot spot¹² wherever it falls.



Action Item

598

599 Ensure your EOC has access to rapid fallout modeling software tools and services that provide fallout
600 hazard area estimations, such as IMAAC. Modeling resources can be found on
601 <https://gis.fema.gov/Model-and-Data-Inventory/>



Coordination Opportunity

602

603 Coordinate with federal peers to access federal modeling capabilities, which track incidents,
604 estimate direction and scale of fallout, and map predicted impact areas.

605 5. Height of Burst (HOB) Considerations

606 The height of the nuclear explosion, relative to ground level, is referred to as the HOB. The HOB impacts the
607 fraction of energy released as thermal energy; fallout hazard magnitude; blast wave strength and interaction
608 with the ground; and the EMP severity and range.

609 5.1. Near-surface Burst

610 A surface burst is a nuclear explosion at or near the surface, in which ground material is incorporated into
611 the resulting nuclear cloud. The mass from ground material reduces thermal output and the range of
612 thermal effects, compared to a low-altitude air burst with the same yield. The ground or nearby material
613 incorporated into the resulting cloud combines with the fission products to form larger fallout particles that
614 'fallout' of the cloud within minutes to hours after detonation. Local fallout radiation levels from a surface
615 burst will probably be high. **In a surface burst scenario, the dominant hazards are blast, local fallout, and**
616 **initial radiation.**

¹² A radiation hot spot is a region in which the radiation levels are significantly higher than in neighboring regions. (US Nuclear Regulatory Commission, 2021)

617 **5.2. Low-altitude Air Burst**

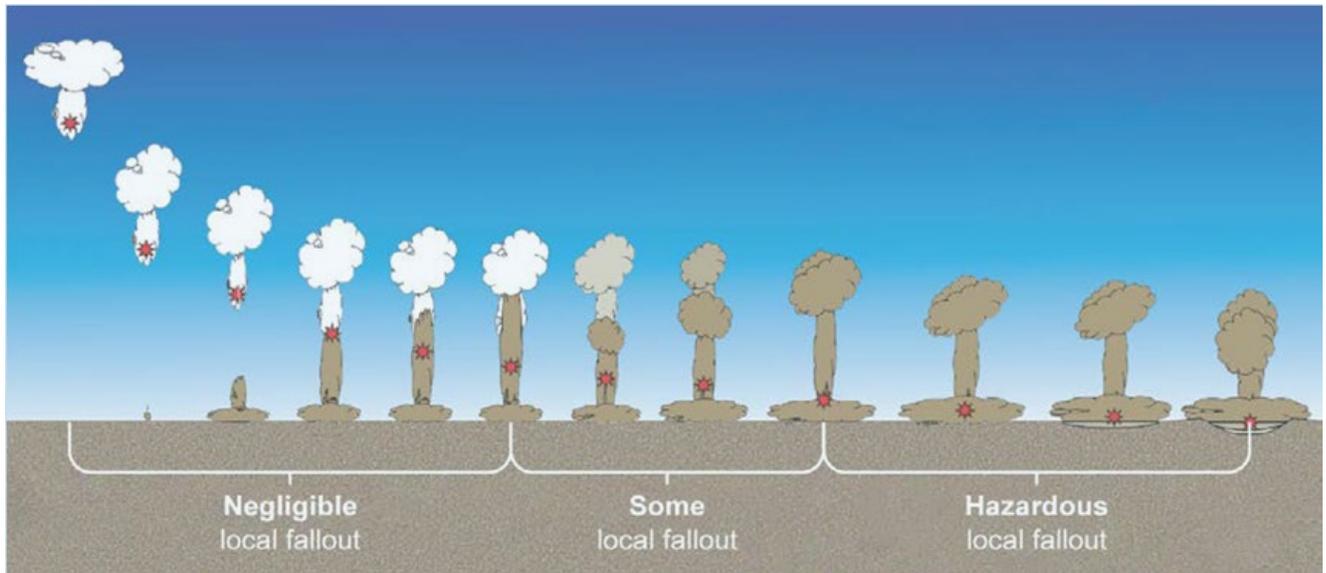
618 A low-altitude air burst is a nuclear explosion at a high enough altitude that the fireball does not interact
619 with the ground, so dirt and debris are not incorporated into the nuclear cloud. Low-altitude¹³ air burst
620 detonations generate larger thermal and blast damage areas than near-surface bursts, but local fallout will
621 be minimal or negligible. The lack of ground material in the nuclear cloud causes fission products to form
622 microscopic particles that remain in the atmosphere for days to months afterwards. Precipitation can
623 cause ‘rainout’ downwind, producing localized, low dose rate radiation hot spots. In a low-altitude air burst
624 scenario, the dominant hazards are blast, thermal (for higher yields), and initial radiation (for lower yields).

625 Figure 12 illustrates nuclear mushroom cloud characteristics for various above ground HOBs (shown by
626 red dots). These clouds can be organized by regimes¹⁴ based on relative HOB. The **negligible local fallout**
627 **regime** in Figure 12 represents air bursts with white mushroom caps, where minimal material from the
628 ground is incorporated into the cloud, so less local fallout is expected. For detonations nearer to the
629 ground, represented by the **hazardous fallout regime** in Figure 12, the cloud cap is darkened by ground
630 material and hazardous levels of local fallout should be expected. For low-altitude air bursts, shown by the
631 clouds in the **some local fallout regime** in Figure 12, partial mixing of ground material with fission products
632 will generate some local fallout, though less severe than that of detonations nearer the surface. Visual
633 observations of the cloud and the color of the cap cloud can help in determining if the detonation is near
634 the surface (darker cap cloud) with more hazardous fallout, or an air burst (cap cloud white or light color
635 compared to the stem of the mushroom cloud) that may indicate less hazardous fallout conditions.
636 Regardless, it is critical to rely on multiple information sources, especially radiation survey measurements,
637 to determine radiation hazards in an area.

638

¹³ For yields considered in this document, low altitude detonations are generally defined as above near-surface detonations, and less than 16,400 ft (5 km) above the surface.

¹⁴ The regimes referenced throughout were derived from Spriggs G. D. et al, 2020.



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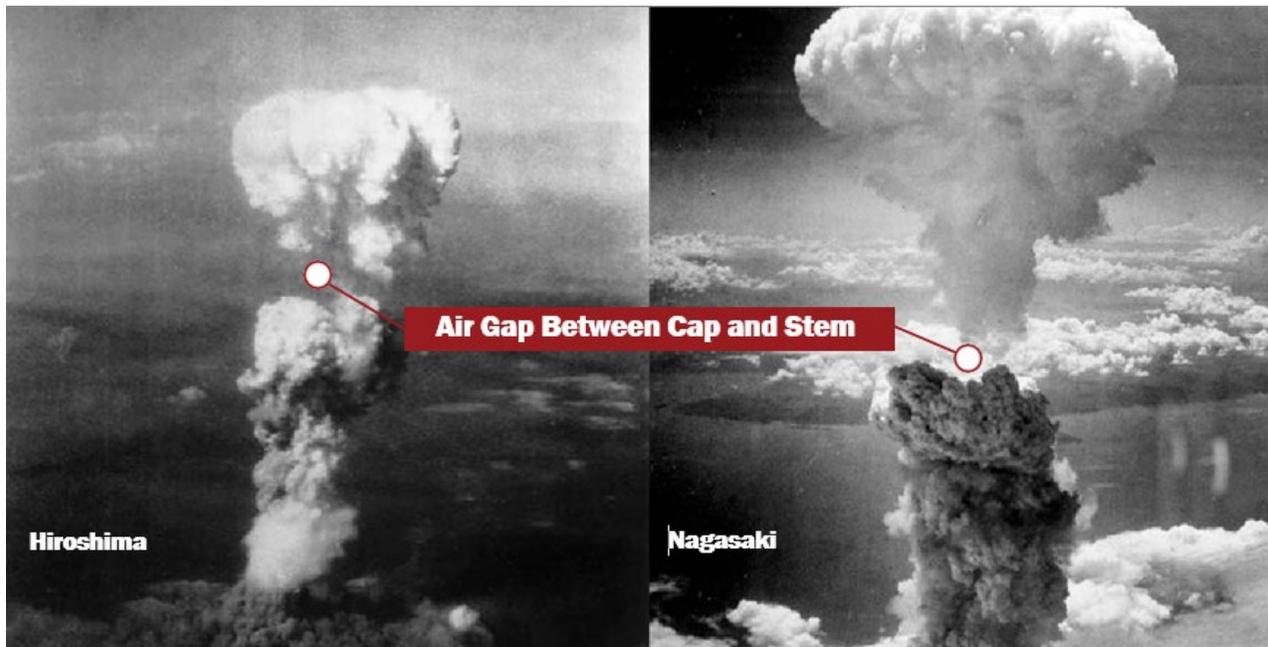
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Figure 12: Examples of cloud shapes and shading for various HOB for a 1 kT detonation. Color of cloud indicates the amount of environmental materials, like dirt, in the cloud, where brown clouds have the most materials and white clouds have the least (derived from Spriggs G. D. et al, 2020).



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Figure 13: Air gap between the white mushroom cap containing fission products and the dark stem of dirt and debris for Hiroshima and Nagasaki.

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In the **negligible fallout regime** (Figure 12), the fallout radiation may be less hazardous, but the initial radiation exposure during the explosion may still harm people. The Hiroshima and Nagasaki detonations are examples of air bursts without significant local fallout, although some victims still suffered radiation sickness from the initial pulse of radiation. The mushroom cloud images from Hiroshima and Nagasaki show an airgap between the cap of the cloud and the stem (see Figure 13). Most of the highly radioactive fission products are fine particles contained within the white cloud cap, which did not mix with the dirt

653 and debris from the ground. The small radioactive particles remained aloft, resulting in minimal local
 654 fallout, and allowing more decay before depositing on the ground.

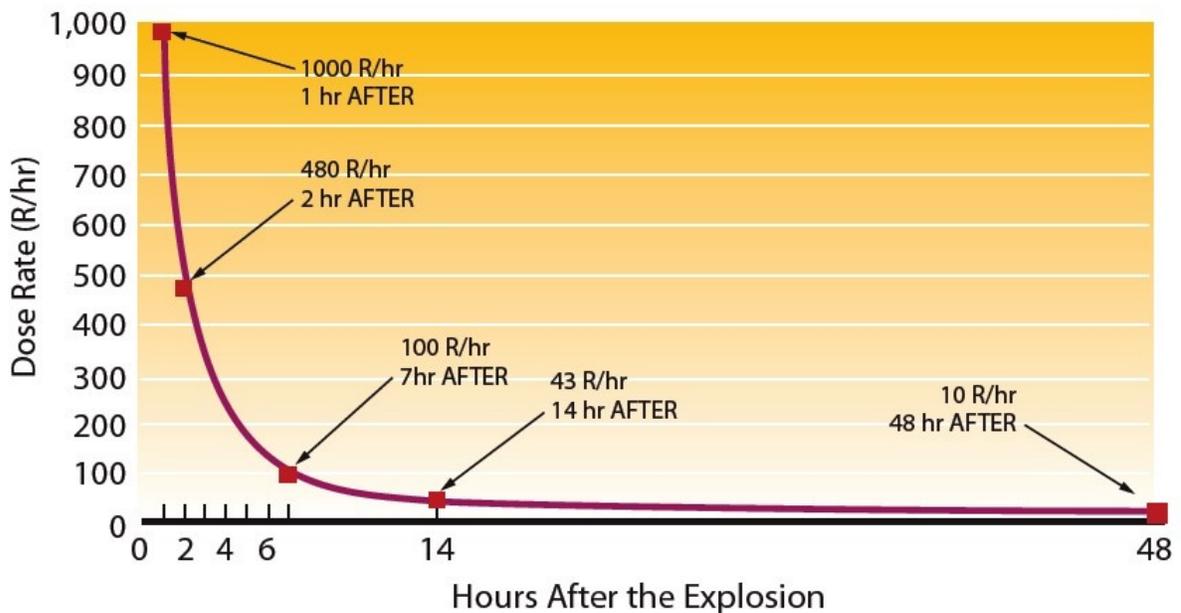


What Would You Do?

655
 656 How would your response actions, based on your plans, change if you knew the cloud was dark
 657 brown? What if the top of the cloud was white?

658 Near-surface detonations (**hazardous local fallout regime**) will generate local fallout, which lands on
 659 surfaces and creates a radiation field. Local fallout is primarily due to large particles that fall relatively
 660 quickly and land on the ground in the first 24 hours. These large particles are too large to drift far with
 661 the wind, easily resuspend, or pose a respirable hazard. Rather, these particles are hazardous because
 662 they emit external gamma radiation, which can travel hundreds of feet through the air. As such, individuals
 663 who are unprotected (e.g., outside) after fallout has deposited may be exposed to radiation.

664 Because many fission products are short-lived, radiation levels decrease rapidly with time. Fallout gives off
 665 over half of its energy in the first hour and then continues to decay rapidly, as shown in Figure 14.
 666 Sheltering is a critical protective measure during the first few hours (up to 24 hours)—for more
 667 information on sheltering, see Chapter 3.



668
 669 **Figure 14: The decay of fallout radiation from the time of detonation. Decay of the fallout product**
 670 **dose rate, from the time of the explosion (not from the time of fallout deposition). The nominal**
 671 **1,000 R/hr starting value in this example is arbitrary.**

672 Although fallout patterns depend on weather conditions, the most dangerous fallout particle
 673 concentrations often occur within tens of miles downwind of ground zero and typically fall within the first
 674 few hours. Wind direction and speed change with altitude which can cause the fallout to be deposited in
 675 more than one direction as demonstrated in Figure 15.

676 Fallout particles near the detonation are relatively large and may be easily visible, as a cloud of debris and
677 as they fall to the ground. Because of their size, the inhalation hazard is small compared to the external
678 dose received from particles on the ground.

679 For response planning, this guidance describes two fallout hazard/residual radiation zones: the DRZ and
680 HZ. Unlike the blast damage zones, the DRZ and HZ are not visually distinguishable and must be
681 determined by radiation level measurements.

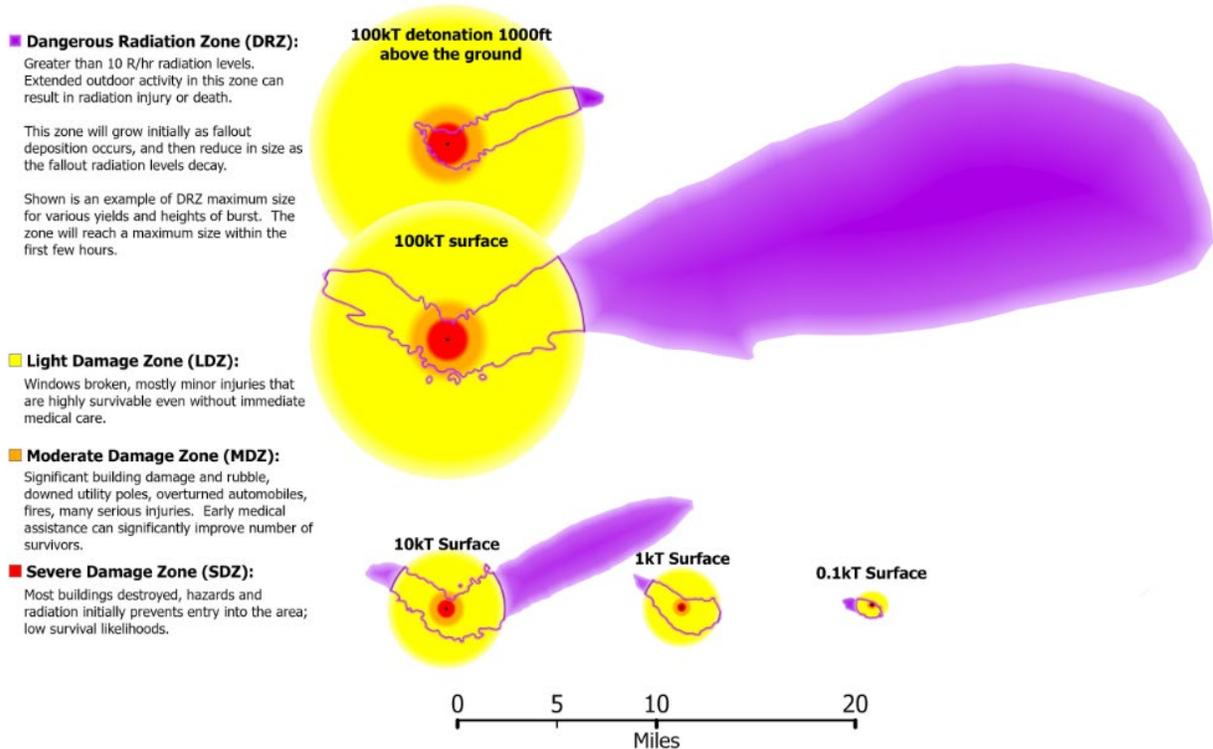
682 **6. Dangerous Radiation Zone (DRZ)**

683 The DRZ is characterized by:

- 684 ▪ Radiation levels of 10 R/hr and above.
- 685 ▪ Potential for acute radiation injury.
- 686 ▪ Potentially tens of miles downwind.
- 687 ▪ This zone will begin to shrink within a few hours due to radiation decay.

688 The DRZ was called the Dangerous Fallout Zone (DFZ) in the previous version of this guidance. This
689 change harmonizes this guidance with other national standards and all other federal guidance for
690 response to radiological or nuclear emergencies.

691 A 10 R/hr radiation exposure rate defines the outside perimeter of the DRZ, with higher exposure rates
692 occurring inside the DRZ. For a near-surface detonation, the SDZ will have DRZ radiation levels within it
693 and the DRZ will overlap with the downwind sides of MDZ and LDZ for near-surface detonations. Figure 15
694 illustrates the relationship between the DRZ and damage zones for various yield and HOB detonations.



695

696

Figure 15: Examples of DRZ impacts from various yields and HOB.

697 The DRZ is very hazardous, so response operations within it must be justified, planned, and optimized to
698 minimize radiation exposure. Responders should refrain from undertaking missions in potentially
699 dangerous areas until radiation levels are known and responder exposures monitored. Responder planning
700 recommendations for the DRZ zone are provided in Chapter 2.

701 Everyone inside the DRZ should seek immediate shelter. Even beyond the DRZ, sheltering may be
702 warranted to minimize acute radiation exposure to the population and minimize cancer risk. Until the
703 magnitude and direction of fallout is established, those not involved in response efforts within 50 miles of
704 a nuclear detonation should seek adequate shelter. See Chapter 3 for additional discussion on finding the
705 best shelter.

706 Response operations in the DRZ should be minimized to protect responders. Monitoring radiation levels is
707 imperative for the response community to identify and address hot spots. Predictive fallout models can be
708 helpful, but measured radiation levels (including aerial measurement surveys) are invaluable when
709 determining response operations and developing protective action decisions.

710 Due to radioactive decay, the DRZ boundary changes rapidly in the first few days. It reaches its maximum
711 extent after the first few hours and then shrinks in size, perhaps going from tens of miles to a mile or two in
712 just one day (see Figure 19).

713



Action Item

714

Ensure methods for obtaining and interpreting radiation readings and models are incorporated in

715

response plans. Consider strategies for collecting, communicating, and mapping radiation readings.

716

7. Hot Zone (HZ)

717

HZ is characterized by:

718

- 0.01 R/hr (10 mR/hr) to 10 R/hr radiation levels.

719

- Operating in the HZ is unlikely to result in acute radiation effects, but radiation dose should be minimized.

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721

- Can extend in various directions for hundreds of miles.

722

- Decay of radioactive material causes this zone to begin shrinking within 24 hours.

723

The residual radiation in the HZ produces radiation exposure rates from 0.01 to 10 R/h. These levels are not immediately dangerous to life or health. However, protective actions (e.g., sheltering and/or evacuation, food restrictions, and water advisories) may be warranted within the HZ to prevent longer term health effects. The HZ can extend hundreds of miles downwind, depending on yield, height of burst, and weather, before shrinking in size due to radioactive decay.

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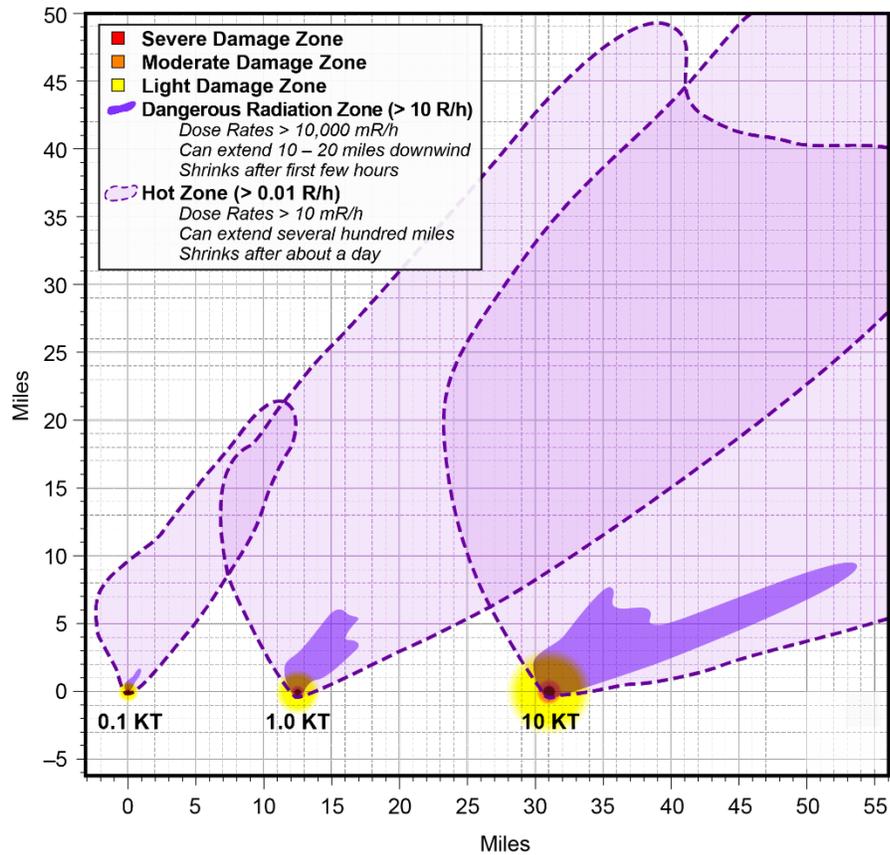
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Emergency operations can be performed in the HZ without exceeding EPA dose guidelines for emergency response operations, provided appropriate dose monitoring and protective measures (e.g., personal protective equipment (PPE)) are taken. Staging, triage, and Community Reception Centers (CRCs) should be established outside of the HZ whenever possible. For more information, see Chapter 2.

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Figure 16: Illustrations of response zones for a variety of yields.

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The HZ, like the DRZ, should be established by measured radiation levels. The HZ is bound by 0.01 R/h and higher exposure rates within the 10 R/h boundary. The SDZ is expected to have HZ radiation levels or higher, even for airbursts. The HZ will overlap with parts of the MDZ and LDZ for near-surface detonations. Figure 16 illustrates the relationship between the HZ, damage zones, and the DRZ for surface detonations of various yields.

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8. Long Range Fallout Impacts

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Near-surface detonations can generate elevated, but low, radiation levels that are easily detected by common responder radiation detection instruments very far from ground zero. Although low level radiation outside of the HZ is not an immediate health concern, local authorities should be aware this may generate public concern.

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This area is not a planning guidance zone because no immediate action is required; however, local authorities may suggest protective actions out of an abundance of caution and long-term epidemiology studies may be warranted.

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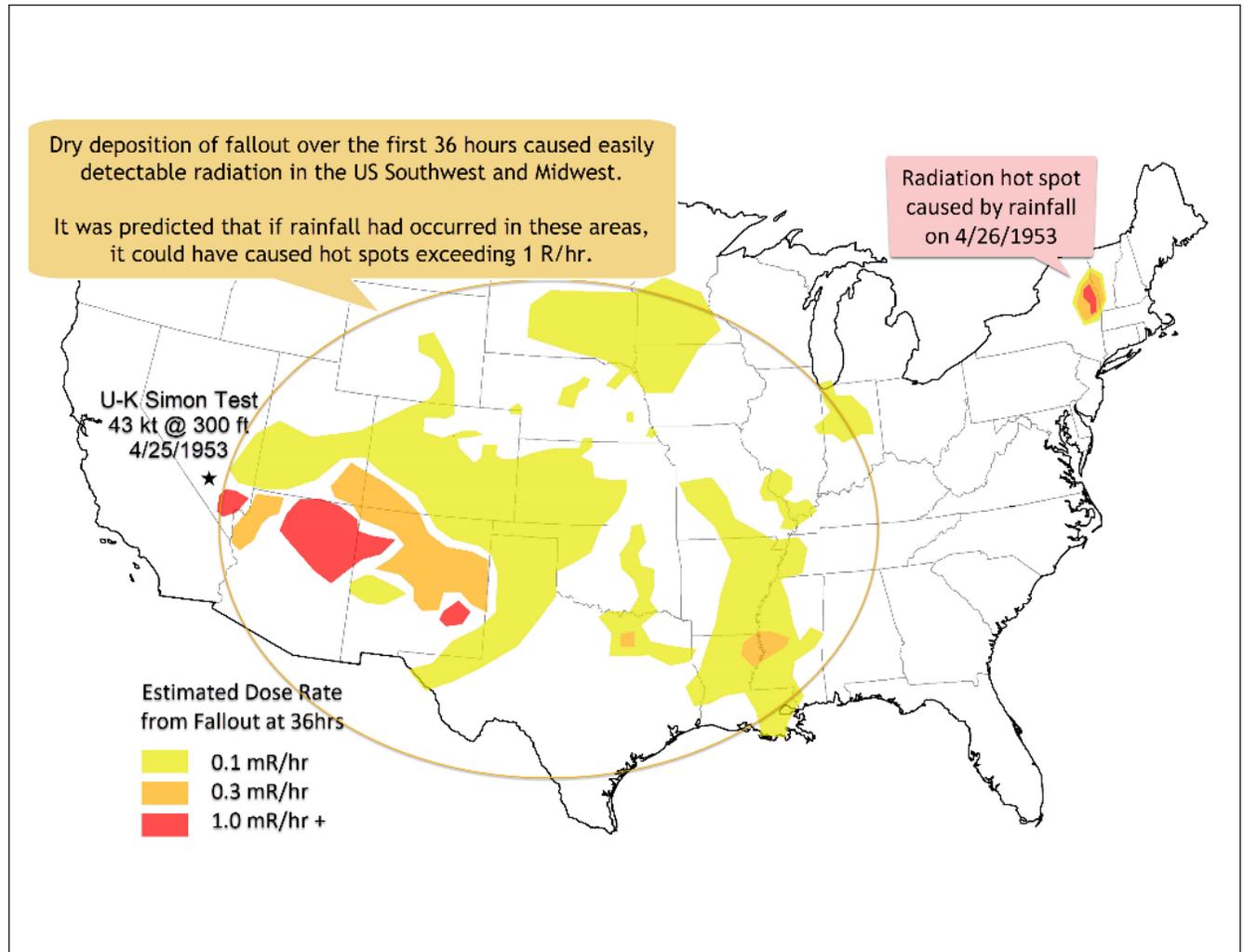
Figure 17, based on data from the National Cancer Institute, shows the measured fallout deposition from the 1953 Upshot-Knothole Simon test in Nevada (a 43 kT detonation on a 300-foot tower). Areas shown in red would have created readings above 1 mR/hr the following day. This was largely due to dry deposition of

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750 the fallout, except for the hot spot that formed in the northeast U.S. that was caused by rainfall that
 751 occurred 36 hours after the test.

752 A similar rain incident in the U.S. Southwest or Midwest within 5-6 hours of the test could have created hot
 753 spots exceeding DRZ levels (> 10 R/h) and local authorities would have had to issue shelter in place orders
 754 to prevent significant exposures. Planners should be aware that precipitation may cause local HZ/DRZ
 755 radiation hot spots that require immediate public protective actions, even a hundred miles or more from
 756 ground zero. The locations of these hot spots are difficult to predict and all jurisdictions that may be at risk
 757 should closely monitor local conditions.



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Figure 17: Estimated gamma dose rate above background levels, if measured 1 m above ground at H+36 hours following one particular U.S. historical nuclear test (Upshot-Knothole Simon on 4/25/1953; 43 kT detonation on a 300-foot tower). Median dose rate estimated by county, from measured fallout activity interpolated across counties (derived from NCI, 1997).

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8.1. Variability of Residual Radiation

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Residual radiation on the ground will vary significantly from one case to another, even for the same nuclear yield and HOB, due to differences in terrain/land use (e.g., rural vs. urban), device design, and

766 meteorological conditions (e.g., wind and precipitation). Widespread and ongoing radiological measurements
767 are essential to confirm HZ/DRZ extents and improve emergency response modeling predictions. (See
768 Appendix 1.2: Residual Radiation Variability for further discussion.)

769 Fallout from air bursts can produce separate, discontinuous HZs or DRZs. For air burst scenarios, the DRZs
770 near ground zero may be small or non-existent (compared to ground burst scenarios of the same yield). An air
771 burst will also have a much smaller HZ, becoming smaller as height of burst increases. However, precipitation
772 events can produce downwind HZ or DRZ hot spots, potentially far from ground zero.

773 Because air burst fallout remains aloft longer and travels farther, detectable radiological deposition may
774 occur at larger downwind distances. Air burst HZs and DRZs can reach regional/continental scales due to
775 both dry settling and wet rainout that deposit radioactive particles on the ground. This may result in
776 widespread demand for radiological emergency response resources, including radiation surveying and
777 population monitoring capabilities.

778 Fallout patterns may be patchy, irregular, and largely unpredictable. Different surfaces, including buildings,
779 can create local patchiness. Precipitation can produce radioactive hot spots on the ground, near the
780 incident, and at longer distances (hundreds or thousands of miles) downwind. This patchiness applies
781 within and across radiation level zones, such as the DRZ and HZ. Fallout models of residual radiation dose
782 rates may be averaged over areas of a square mile or more. Consequently, models do not predict localized
783 exposure rate variations and responders may encounter localized, non-uniform residual radiation hot
784 spots early in the response that can only be identified with real-time measurements.

785 9. Zone Summary

786 This guidance is characterized by several important planning zones:

- 787 ▪ **Severe Damage Zone (SDZ):** destroyed infrastructure and high radiation levels
- 788 ▪ **Moderate Damage Zone (MDZ):** significant building damage, rubble, downed utility lines and some
789 downed poles, overturned automobiles, fires, and serious injuries
- 790 ▪ **Light Damage Zone (LDZ):** broken windows and easily managed injuries
- 791 ▪ **Dangerous Radiation Zone (DRZ):** prolonged outdoor exposure can result in injury or death
- 792 ▪ **Hot Zone (HZ):** actions warranted to reduce radiation exposure to reduce the possibility of long-term
793 health effects

794 10. Radiation Injuries and Fallout Health Impacts

795 In fallout areas, external radiation exposure can be a significant health concern. High radiation doses can
796 cause acute health effects (potentially deadly in a short time), and long-term health effects, especially
797 cancer. One of the long-term (years) radiation effects can be an increased risk of cancer. Minimizing
798 exposure to radiation is a valuable policy and response goal, for both responders and the public. Generally,

799 a radiation dose received over a long period of time is less likely to result in health effects than if the
800 same dose were received over a short period of time.

801 Minimizing dose levels is a priority in the DRZ, due to potentially acute effects and lethal doses. Further
802 downwind, in the HZ, adequate shelter is critical to reduce unnecessary radiation exposures. Chapters 2
803 and 3 provide more information on radiation dose management and protective actions. Chapter 4 provides
804 more information on the effects of various radiation exposures.

805 The most effective life-saving opportunity for response officials in the first 60 minutes following a
806 nuclear explosion will be for people in possible fallout areas to be safely sheltered. Fallout exposure
807 can be effectively minimized by taking shelter in a sufficiently protective structure. The outdoor
808 radiation hazard from fallout (often referred to as the 'ground shine dose') is typically orders of
809 magnitude more hazardous than internal exposure concerns resulting from inhalation or ingestion of
810 radioactive material. Even buildings with broken windows can provide adequate protection from
811 ground shine dose. For more information on sheltering, see Chapter 3.

812 Rudimentary decontamination may be necessary for those leaving fallout areas or entering shelters.
813 Effective external decontamination is straightforward—remove/change the outer layer of clothing and
814 brush/wipe exposed skin. If contamination is not brushed or washed off, particles in contact with the skin
815 can cause localized beta burns¹⁵. For decontamination information, see Chapter 5. People caught in an
816 area while fallout is depositing should find suitable shelter and perform dry decontamination to brush off
817 any fallout particles.

818 **10.1. Radiation Dose from Fallout**

819 Dose caused by external exposure occurs when the radiation source is outside the body. This includes
820 initial radiation, ground contamination, and contamination on the clothing or skin. Removing the person
821 from the radioactive environment, or removing the contamination from the clothing or skin, stops the
822 exposure.

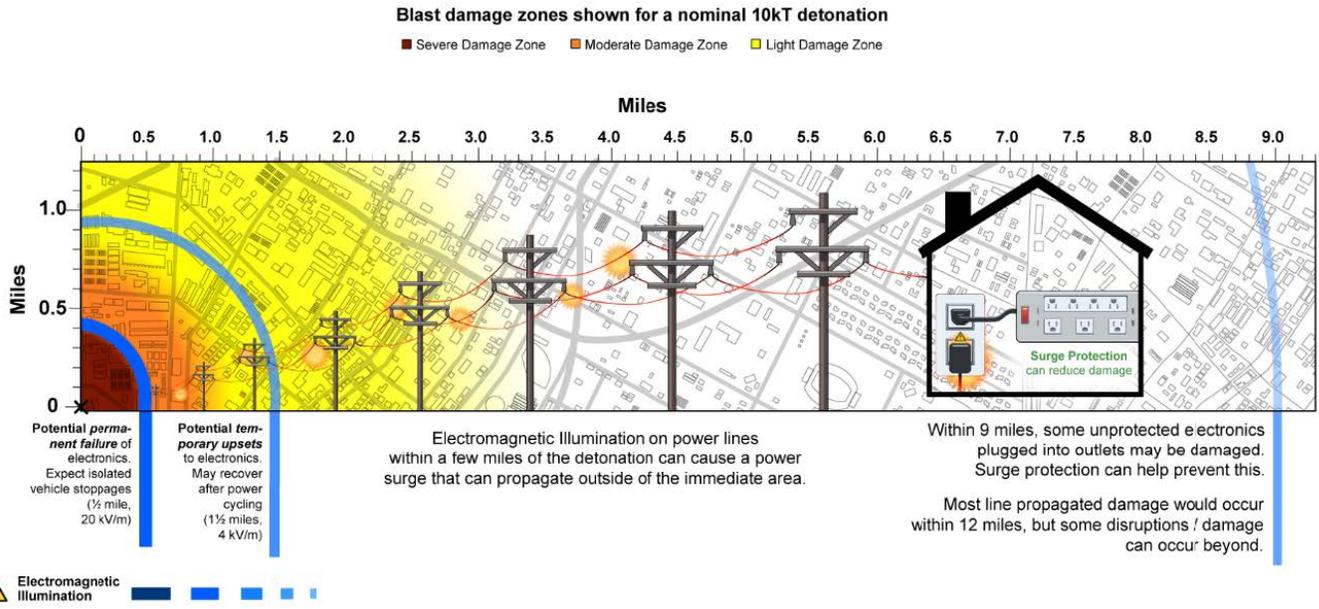
823 Dose caused by inhalation or ingestion of fallout is not a primary concern during initial phases of the
824 response. Historical data demonstrates that dose from these sources is less than 10% of total dose
825 received while being outside in fallout areas where the primary hazard is external exposure.

826 **10.2. Combined Injuries**

827 When a radiation injury from radiation exposure occurs in conjunction with trauma and/or burns, it is
828 called "combined injury". Combined injury carries a worse prognosis than either of the same injuries
829 occurring alone. Therefore, patients with combined injury will be triaged differently than patients with only
830 one type of injury. See Chapter 4 for more information about medical concerns.

¹⁵ Beta burns are severe sunburn-like injuries caused by beta radiation from particles deposited on the skin.

831 11. Electromagnetic Pulse (EMP) Effects



832

833 **Figure 18: Source Region EMP (SREMP) illumination range and power grid coupling disruptions.**

834 EMP from a low-altitude¹⁶ detonation differs from high altitude¹⁷ EMP (HEMP). High altitude bursts
835 generate three distinct EMP components, while EMP from a low-altitude detonation is generally limited to a
836 Source Region EMP (SREMP).

837 There are two major disruptive effects of a SREMP, which are shown in Figure 18 above:

- 838 1. Electromagnetic (EM) Illumination: SREMP impact electronic equipment through induced voltage on
839 internal wires and conductors. These induced voltages may disable or damage equipment, depending
840 on field strength.
- 841 2. Line Coupling: Large voltage/current surges in long power lines and other conductors that pass near
842 the detonation. This can propagate the EMP significant distances, resulting in disruption and potential
843 damage a few miles outside the blast damage area.

844 Key points on SREMP associated with the planning guidance scenarios:

- 845 ■ EMP effects are not strongly dependent on yield or HOB below 3 miles (5 km).
- 846 ■ Temporary (hours to days) power outages may extend tens of miles beyond the blast damage area,
847 depending on power grid configuration and detonation location.

¹⁶ For the purpose of EMP effects, anything less than ~16,400 ft above ground level (AGL) is considered low altitude.

¹⁷ Greater than 30 km AGL.

- 848 ▪ Power system transformer damage (difficult to repair quickly) from EMP effects is generally limited to a
849 few miles from ground zero.
- 850 ▪ EM illumination on power lines within a few miles of detonation can cause power surges outside the
851 MDZ that can damage unprotected equipment plugged into wall sockets up to 9 miles away.
- 852 ▪ Easily repairable damage to power system substation components (tripped breakers, damaged relays,
853 etc.) can occur several miles from the detonation, along long running non-branching power lines.
- 854 For an in-depth discussion of EMP affects, see Appendix 1: EMP, HEMP, Geomagnetic Disturbance (GMD),
855 and SREMP.

856 Chapter 2: A Zoned Approach

857 This chapter examines the five key response zones introduced in Chapter 1 (see Figure 19) and identifies
858 their hazards, response priorities, public protection priorities, and emergency worker protective measures.
859 Hazards and radiation zones change over time and depend on specific detonation characteristics,
860 especially the yield and HOB.

861 Effective nuclear detonation response requires all available resources. Due to geographically expansive impacts,
862 responders and emergency management organizations will be present in many of the zones discussed below.
863 In addition to ensuring their own safety, response organizations must prioritize both lifesaving activities and
864 developing situational awareness to facilitate a coordinated and rapid response.

865 Since a planning document cannot anticipate all problems and solutions in advance, this document
866 establishes an adaptable, zoned approach to prioritize response activities and coordinate collective allocation
867 of scarce resources among jurisdictions, states, and regional organizations. This approach provides flexibility
868 to responders who must process an overwhelming amount of incident information and rapidly generate
869 prioritized response actions.

870 To support response, neighboring jurisdictions must develop a COP. Response priorities and public
871 protective measures differ for large fires and fallout, so determining the extent of both hazards is an
872 important initial priority.

873 Although the bulk of federal support will not be available in the first 72 hours, some remote assistance
874 (such as modeling and public messaging) will be available almost immediately. FSLTT jurisdictions must
875 prepare to receive and integrate national response resources. Federal assistance includes specialized
876 nuclear/radiological capabilities described in the Nuclear/Radiological Incident Annex (NRIA) to the
877 Response and Recovery Federal Interagency Operational Plans (FIOPs). To access specialized
878 nuclear/radiological planning and response tools, contact FEMA's CBRN Office.

879 Coordination Opportunity

880 Response to a nuclear detonation may largely be provided by neighboring jurisdictions, so advanced
881 planning is required to establish mutual aid agreements and response protocols.

882 Action Item

883 Emergency responders and planners must understand how to obtain and use IMAAC products.

884



Refer To

885

NRIA to FIOPs: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf

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887 Although previous nuclear detonations have informed our understanding of nuclear effects, there is
888 uncertainty about what would occur if a nuclear device exploded in a modern U.S. city. Modeling may
889 estimate the extent and magnitude of affected areas based on simplified assumptions, but the zones will
890 ultimately be identified through physical observations and real-time radiation readings from emergency
891 workers in the area.

892 A zoned approach tailors response to the hazards present in different areas surrounding the detonation.
893 However, regardless of zone, the best initial protective action the public can take is to “Get Inside, Stay
894 Inside, Stay Tuned.” This guidance is applicable to scenarios with limited (tens of minutes) warning as well
895 as no-notice incidents. As with all guidance, immediate threats to life take priority, so evacuation may be
896 warranted in the event of fire, building collapse, or medical emergencies.

897 “Get Inside, Stay Inside, Stay Tuned” is the most important protective action, because it mitigates
898 fallout exposures:

- 899 ▪ **Get Inside** a basement or the middle of a large, dense building¹⁸. It is best to be in a shelter when
900 fallout arrives. Any shelter is better than being outside for extended periods of time.
- 901 ▪ **Stay Inside** for 12 – 24 hours, unless provided additional guidance.
- 902 ▪ **Stay Tuned** for instructions and updates. AM/FM radio is best, but television, cell phone, or
903 internet options are viable, if available. For more information on emergency messaging, see
904 Chapter 7.

¹⁸ For more information about adequate shelters, and a discussion of dense buildings, see Chapter 3.

Radiation Zones

(Approximate for a 10kT)

Dangerous Radiation Zone (DRZ)

- Bounded by radiation levels of 10 R/hr
- Acute Radiation Injury possible within the DRZ
- Could reach 10-20 miles downwind
- Begins to shrink after about 1-2 hours

Hot Zone

- Bounded by radiation levels of 0.01 R/h (10 mR/h)
- Acute radiation effects unlikely, however steps should be taken to control exposure
- Could extend in a number of directions for 100s of miles
- Begins to shrink after 12-24 hours
- After ~ 2 weeks the Hot Zone will be the size of the maximum extent of the DRZ (10-20 miles)

Blast Zones

(Approximate for a 10kT)

Severe Damage Zone (half-mile radius)

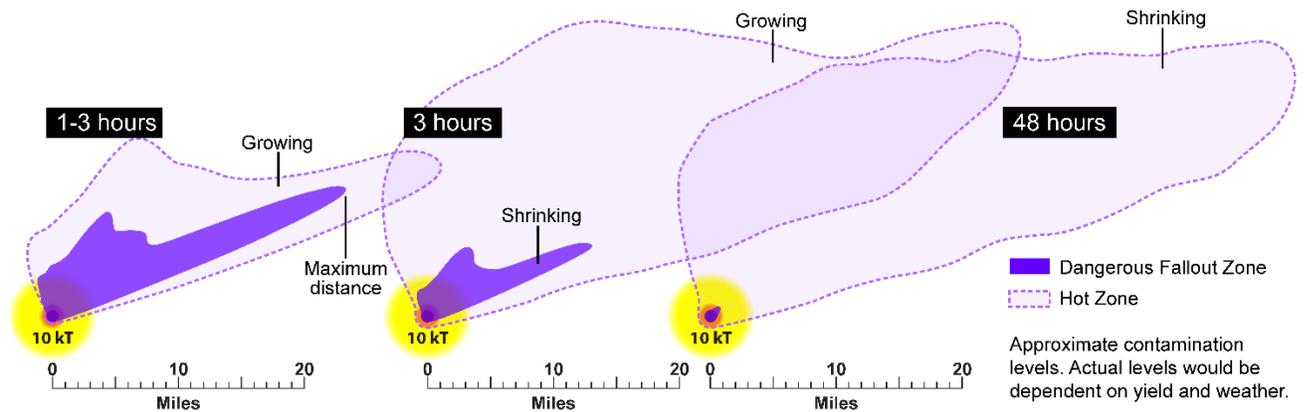
Most buildings destroyed, hazards and radiation initially prevents entry into the area; low survival likelihood.

Moderate Damage Zone (half- to 1-mile radius)

Significant building damage and rubble, downed utility poles, overturned automobiles, fires, and many serious injuries. Early medical assistance can significantly improve the number of survivors.

Light Damage Zone (1- to 3-mile radius)

Windows broken, mostly minor injuries that are highly survivable even without immediate medical care.



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Figure 19: Depictions and descriptions of the five planning guidance zones.

907 1. Hazard Zones

908 This document defines 5 key radiation and blast zones for planning response operations and prioritizing
 909 actions. Each zone has different response priorities and survival implications. Radiation zones will overlap
 910 blast zones and initially grow over time, as fallout deposits downwind, then shrink as the radiation decays.

911 1.1. Radiation Zones

912 As described in Chapter 1, residual radiation from the nuclear detonation can create persistent radiation
 913 hazards, long after initial effects have subsided. Fallout is generated when radioactive material mixes with
 914 dirt and debris pulled up during a near-surface explosion. Because of uncertainty about the magnitude
 915 and direction of fallout, an initial “Get Inside, Stay Inside, Stay Tuned” instruction should be provided to
 916 everyone within 50 miles, unless specific fallout hazard areas have been identified.

917 Radiation levels change rapidly over time. Fallout accumulates downwind then rapidly decays, emitting over
 918 half of its energy in the first hour. After the first few hours, radiation levels drop, allowing responders to
 919 access previously restricted areas.

920 Responders can perform their duties while minimizing radiation exposure risks, provided they have
921 appropriate knowledge and equipment¹⁹. For example:

- 922 ▪ Responders without radiation detection instruments should shelter until informed it is safe to
923 respond.
- 924 ▪ Responders with radiation detection instruments should shelter and use their radiation detection equipment
925 to monitor and report local radiological conditions:
 - 926 ○ If outdoor radiation levels exceed 10 R/hr, responders should continue to shelter (unless there is a
927 time critical, life safety issue, such as a fire, building collapse, or medical emergency).
 - 928 ○ If outdoor radiation levels are below 10 R/hr, responders should assess their immediate area for
929 hazards. However, for the first few hours, responders should stay near adequate shelters and
930 closely monitor radiation levels. If radiation levels increase rapidly, responders should shelter
931 immediately.

932 Emergency workers should keep individual radiation exposures as low as reasonably achievable
933 (ALARA)²⁰ without hindering their ability to save and sustain life.

934 **1.1.1. DANGEROUS RADIATION ZONE (DRZ)**

935 **Description:** Area where radioactive contamination creates outdoor exposure rates above 10 R/hr.
936 Radiation levels are high enough to cause radiation injury or death if people are exposed for extended
937 periods. This zone reaches maximum size in the first few hours then shrinks rapidly as radioactive fallout
938 decays.

939 **Public actions:** “Get Inside, Stay Inside, Stay Tuned” for at least 12-24 hours, unless threatened by fire, building
940 collapse, medical needs, or other immediate threats. Seek adequate shelter in basements or the center of
941 larger, dense buildings (as described in Chapter 3). Any shelter is better than being outside for extended
942 periods. Stay tuned for public announcements about hazard areas and evacuations.

943 **Responder actions:** Shelter-in-place or avoid this area, unless undertaking critical, planned protection
944 activities for large populations. Responders in this zone need radiation monitoring equipment to alert them
945 of excess exposure. Wear PPE appropriate for all hazards present, including non-radiological hazards.
946 Emergency workers should only enter this area after being fully informed of the risks.

¹⁹ These bullets are derived from NCRP Commentary No. 179 – Guidance for Emergency Response Dosimetry, and reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

²⁰ The guiding principle of radiation safety is ALARA. This principle means that even if it is a small dose, if receiving that dose has no direct benefit, you should try to avoid it. For more information, visit [the CDC website on the radiation ALARA principle](#).

947 Additional information:

- 948 ▪ External exposure dominates total radiation dose. Inhalation or ingestion of radioactive particles is a
949 secondary concern. Inhalation PPE may still be needed for other hazards (e.g., smoke and dust),
950 though should not be a priority for radiation related concerns.
- 951 ▪ Precipitation and weather may create irregular patches of dangerous radiation levels, sometimes well
952 outside the main fallout areas. Use radiation detection equipment whenever possible to verify
953 conditions and identify these areas.
- 954 ▪ In the DRZ, lacking adequate shelter can cause radiation injuries. Adequate shelter is described in
955 detail in Chapter 3 and significantly shields those within from radiation. Adequate shelter reduces
956 radiation dose by a factor of ten or more.
- 957 ▪ Emergency worker dose guidelines: Based on the EPA *Manual of Protective Action Guides and*
958 *Protective Actions for Radiological Incidents*, the dose guideline for lifesaving activities is 250 mSv (25
959 rem) for responders over the course of the entire response. The dose guideline for protection of
960 property is 100 mSv (10 rem) for the incident. The occupational dose limit of 50 mSv (5 rem) per year
961 applies to all other work. These guidelines can be exceeded for lifesaving actions, under certain
962 conditions (see protective action guidelines (PAGs) for details regarding these conditions).
- 963 ▪ Planners must establish maximum responder doses and dose rates, beyond which operations require
964 justification for continued responder exposure.
- 965 ▪ Most fallout contamination on a person can be eliminated by a change of clothes and brushing off or
966 wiping exposed skin.
- 967 ▪ When evacuating, people should move away from the detonation location and avoid/quickly evacuate
968 the DRZ.

969  Refer To

970 Manual of Protective Action Guides and Protective Actions for Radiological Incidents:

971 [https://www.epa.gov/sites/production/files/2017-](https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf)

972 [01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf](https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf)

973 1.1.2. HOT ZONE (HZ)

974 **Description:** Outdoor exposure rates are between 0.01 R/hr (10 mR/hr) and 10 R/hr. Radiation levels
975 are low enough that there is no immediate danger, but high enough to warrant protective measures that
976 reduce long-term health risks, including cancer. This zone may extend in multiple directions for hundreds of
977 miles. It will likely reach its maximum size after about a day, then shrink. Weather and terrain will likely
978 create an irregular shape, including hot spots, due to non-uniform dispersal or precipitation.

979 **Public actions:** “Get Inside, Stay Inside, Stay Tuned” for at least 12-24 hours unless threatened by fire,
980 building collapse, medical needs, or other immediate threats. Ideally, shelter in basements or the center of
981 larger, dense buildings (as described in Chapter 3). Any shelter is better than being outside for extended
982 periods of time. In many areas, fallout will arrive an hour or more after the detonation. Stay tuned for
983 public announcements about hazard areas and evacuations.

984 **Responder actions:** Monitor radiation levels. Minimize radiation exposure by limiting time spent outdoors.
985 Wear PPE appropriate for all hazards present, particularly non-radiological hazards. Support more heavily
986 impacted zones (LDZ, MDZ) if possible and do not delay local emergency response activities.

987 Additional Information:

- 988 ▪ Radiation exposure should be kept ALARA. Sheltering, possibly followed by a delayed evacuation, is
989 recommended, even at long distances downwind. Seek adequate shelter if possible (based on
990 guidance in Chapter 3).
- 991 ▪ Radiation monitoring equipment should be used in the HZ, to alert the responders when they are
992 nearing or entering the DRZ.
- 993 ▪ The HZ will overlap the SDZ, MDZ, and LDZ. In overlap areas, public and responder actions should be
994 driven by damage zone hazards and priorities.
- 995 ▪ Precipitation may create HZ patches hundreds of miles from ground zero, which are difficult to predict
996 with modeling tools. Use radiation detection equipment whenever possible to verify conditions.
- 997 ▪ Medical emergencies take precedence over radiological concerns in the HZ. Lifesaving operations
998 should not be delayed for radiation exposure/contamination concerns.

999 Where the HZ overlaps with the LDZ or MDZ, response activities should be guided by LDZ and MDZ
1000 priorities. Radiation monitoring should be performed to ensure responders avoid entering the DRZ
1001 unnecessarily.

1002 There will be a large region where elevated radiation can be detected. Although these radiation levels
1003 may generate public concern, outside the DRZ and HZ, no immediate action is warranted. These
1004 radiation levels may generate public concern.

1005 **1.2. Blast Damage Zones**

1006 As described in Chapter 1, the blast wave will damage buildings and infrastructures, with decreasing
1007 severity farther from ground zero. For planning and response purposes, the damage has been categorized
1008 into three zones—the SDZ, MDZ, and LDZ, as described in Chapter 1.

1009 Blast damage mechanisms and the area impacted vary based on terrain, urban building density, and
1010 atmospheric conditions. Subsequently, responders must determine blast damage zones through **visual**
1011 **observations of damage**. Models provide estimated zones for planning; however, actual zones will not be as
1012 clearly defined as model results imply. To highlight expected uncertainty and variability, many graphics in

1013 this document do not have sharp boundaries or transitions. To provide basic, generic parameters, this
1014 document assumes a nominal 10 kT detonation. While distances would vary, the zone descriptions apply
1015 to any size nuclear explosion.



Refer To

1017 *What to do DURING:* [https://www.ready.gov/sites/default/files/2020-11/ready_nuclear-](https://www.ready.gov/sites/default/files/2020-11/ready_nuclear-explosion_fact-sheet_0.pdf)
1018 [explosion_fact-sheet_0.pdf](https://www.ready.gov/sites/default/files/2020-11/ready_nuclear-explosion_fact-sheet_0.pdf)

1019 1.2.1. SEVERE DAMAGE ZONE (SDZ)

1020 **Description:** Area where few, if any, buildings remain standing or structurally sound. Access and movement
1021 in the area will be extremely limited due to rubble and debris. Those outside at the time of detonation will
1022 not survive. People in robust structures or underground areas may survive, but will be at risk, due to
1023 building collapse and radiation exposure. Underground infrastructure damage inside the SDZ could affect
1024 areas outside of the SDZ (such as damaged water pipes in the SDZ affecting the water pressure in other
1025 areas).

1026 Near ground zero, the blast can damage tunnels and underground infrastructure. This underground
1027 damage area is limited and well within the SDZ, but infrastructure damage inside the SDZ could affect
1028 areas outside of the SDZ (such as damaged water pipes in the SDZ affecting the water pressure in other
1029 areas).



1030

Figure 20: The destruction of the World Trade Towers on 9/11/2001 is similar to the type of damage that might be seen in the SDZ.

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1032

1033 Observables and considerations

- 1034 ■ The SDZ may have a radius of $\sim\frac{1}{2}$ mile for a 10 kT detonation.

- 1035 ▪ Responders should enter this zone with great caution and only to rescue known survivors after
1036 assessment of potential radiation exposure and other hazards.
- 1037 ▪ Very few people will survive in the SDZ. Some people within large, protective structures; underground
1038 parking garages; or subway tunnels at the time of the explosion may survive the initial blast.
- 1039 ▪ Timely response is unfeasible in the SDZ—response operations should focus first on the LDZ and MDZ.
- 1040 **Blast**
- 1041 ▪ Few, if any, buildings are expected to be structurally sound or even standing.
- 1042 ▪ Approaching ground zero, all buildings will be destroyed, and the streets will be impassable due to
1043 rubble (which can reach 30+ ft deep).
- 1044 **Radiation**
- 1045 ▪ Those outdoors at the time of detonation may receive a lethal dose of initial radiation and even those
1046 within buildings can receive a significant dose.
- 1047 ▪ Underground areas, such as subterranean parking garages or subway tunnels, can protect against
1048 radiation.
- 1049 ▪ Residual radiation levels outdoors will likely be dangerous.
- 1050 **Thermal**
- 1051 ▪ The thermal pulse will ignite fires and cause lethal burns to those with a line-of-sight to the fireball.
- 1052 ▪ Blast wave effects may prevent further fire growth by effectively blowing out fires started by the thermal
1053 pulse and burying combustible materials.
- 1054 **EMP**
- 1055 ▪ The EMP may damage or disrupt electronic equipment. Some commercial band AM/FM radios will still
1056 be able to receive signals from transmitters outside the area.
- 1057 ▪ Power will be out.
- 1058 **Public actions:** Stay indoors unless in danger from fire, building collapse, medical emergency, or other
1059 imminent threat. Allow 12-24 hours for radiation levels to decay, and then use protected escape routes
1060 (e.g., connections between buildings, tunnels, core areas within buildings, sidewalk overhangs, and the
1061 shortest distances between adjacent structures) if possible.
- 1062 **Responder actions:** Due to likely hazardous outdoor radiation levels and the technical nature of mounting a
1063 response in an area of near complete destruction, this zone is not a priority and response resources should
1064 be used elsewhere. Responders entering the SDZ should wear PPE appropriate for the non-radiological

1065 hazards (e.g., fire, sharps, hazardous dust, smoke) and use high range radiation monitoring instruments
1066 (see Appendix 2.1 for instrument information).

1067 Response within the SDZ should not be attempted until radiation dose rates have dropped
1068 substantially in the days following a nuclear detonation. When more resources become available later
1069 in the response, the radiation dose rates within the SDZ should be reassessed. All response missions
1070 must be justified to minimize responder risks.

1071 1.2.2. MODERATE DAMAGE ZONE (MDZ)

1072 **Description:** Area with substantial damage to most structures and minor damage to heavily reinforced
1073 structures. People in this zone may experience injuries or death from blast over-pressure, building collapse,
1074 flying debris, fires, and thermal burns. Radiation injuries and deaths may occur, even in cases without
1075 significant fallout.



1076
1077 **Figure 21: Example of MDZ-like blast damage.**

1078 Observables and considerations

- 1079 ▪ Building damage is substantial in the MDZ. MDZ damage may be ~ 1 mile from ground zero for a 10 kT
1080 nuclear explosion.
- 1081 ▪ Many casualties in the MDZ will survive and will benefit the most from urgent medical care, compared
1082 to survivors in other zones.
- 1083 ▪ A number of hazards should be expected in the MDZ, including elevated radiation levels, downed
1084 power lines, ruptured gas lines, unstable structures, sharp metal objects, broken glass, toxic dust from
1085 collapsed buildings, ruptured fuel tanks, and other hazards.
- 1086 ▪ Visibility in much of the MDZ may be limited due to dust raised by collapsed buildings and smoke from
1087 fires.
- 1088 ▪ Water infrastructure may be damaged, limiting firefighting operations.

1089 **Blast**

- 1090 ▪ Buildings in the MDZ will have significant structural damage and blown out interiors. Downed utility
1091 lines, overturned automobiles, caved roofs, collapsed buildings, and fires will be present. Sturdier
1092 buildings (e.g., reinforced concrete) will remain standing; however, other commercial and multi-unit
1093 residential buildings may have fallen or be structurally unstable, and many wood frame houses will be
1094 destroyed. For additional information about how different structures will fare, see Chapter 3.
- 1095 ▪ Substantial rubble and disabled vehicles are expected in the streets, making evacuation and vehicle
1096 passage difficult or impossible without street clearing. Closer to ground zero, rubble will completely
1097 block streets and require heavy equipment to clear.

1098 **Radiation**

- 1099 ▪ For near-surface detonations that generate fallout, dangerous radiation levels will exist downwind of
1100 ground zero within the MDZ.
- 1101 ▪ Initial radiation may cause significant radiation dose to those outside during the detonation, especially
1102 for lower yields (less than 10 kT).

1103 **Thermal**

- 1104 ▪ For air bursts and yields greater than 10 kT, the thermal pulse can ignite fires and cause lethal burns to
1105 those with line-of-sight to the fireball.
- 1106 ▪ Fires will be a major concern in the MDZ. Depending on weather conditions, these fires can spread
1107 quickly and may coalesce into a firestorm.

1108 **EMP**

- 1109 ▪ The EMP may damage or upset some electronic equipment in this area, however, most battery-
1110 operated equipment should work after power cycling (turning off, then on again).
- 1111 ▪ Unprotected equipment plugged into wall outlets may be damaged due to power surge.
- 1112 ▪ Commercial band AM/FM radios will be able to receive signals from transmitters outside the area.
- 1113 ▪ Power will likely be out in this area.

1114 **Public actions:** Seek immediate shelter in a large, dense building. Stay sheltered unless threatened by fire or
1115 building collapse. Tune in to local radio to determine radiation hazard. Evacuate if directed or experiencing
1116 life-threatening conditions, such as impending building collapse, fire, or medical emergency.

1117 **Responder actions:** The MDZ has the greatest lifesaving potential through early responder actions. Monitor
1118 radiation levels and avoid the DRZ. Perform rescue and life-saving activities, such as firefighting, when
1119 possible. Wear PPE appropriate for the non-radiological hazards (e.g., fire, sharps, hazardous dust, smoke)
1120 and adhere to the radiation monitoring guidance below.

- 1121
- 1122
- 1123
- 1124
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- 1126
- 1127
- 1128
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- 1130
- 1131
- **MDZ Outside of the DRZ (i.e., exposure rate less than 10 R/h): Manage fires and support evacuation. Fire and building collapse are an immediate and direct threat in this zone.** Response organizations must clear and maintain safe evacuation corridors. There will be many serious injuries that require evacuation. Use radiological monitoring equipment that alerts users if they approach a HZ or DRZ. If working in the HZ, follow the responder protection measures in the HZ description above.
 - **MDZ with DRZ Overlap (i.e., exposure rate greater than 10 R/h): Manage fires remotely, if possible, recommend sheltering if safe to do so, and enable public egress to escape life-threatening conditions.** Minimize outdoor responder activities. Monitor radiological conditions and operate outside the DRZ when possible. Only conduct short, focused, and critical activities in the DRZ. Access to the DRZ will increase over time as radiation levels decay. Responders in this zone should have high range radiation monitoring equipment that alerts them to high exposure rates and excessive dose.

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1134

In the MDZ, fire and building collapse represent an immediate threat. Response organizations should perform defensive tactics to maintain evacuation corridors and facilitate evacuation in areas when safe to do so.

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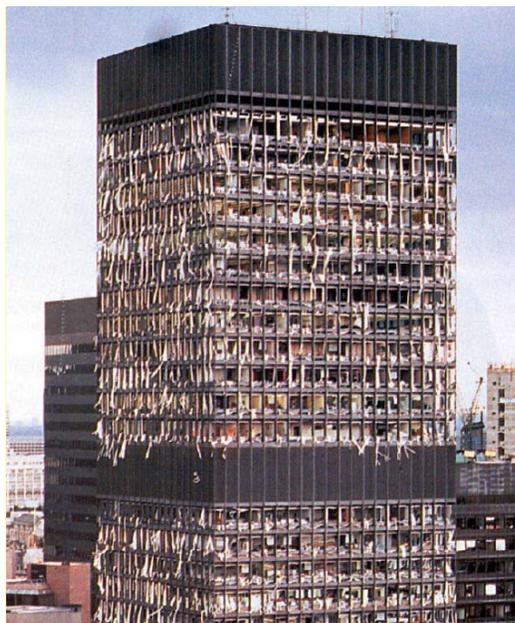
The MDZ should be the focus of early life-saving operations. Response activities should focus on evacuation of endangered populations and medical triage of the injured.

1137 1.2.3. LIGHT DAMAGE ZONE

1138 **Description:** Area where glass windows can be broken with enough force to injure those near them. Most

1139 structures will be externally damaged, but few will experience structural damage (see Figure 22). (Note:

1140 glass windows will be broken over a much larger area, but are unlikely to result in injury outside this zone)



1141

1142 **Figure 22: Example of LDZ-like blast damage.**

1143 **Observables and considerations**

1144 ▪ Nearly all windows in this area are broken (even those facing away from the blast). Flying debris will
1145 cause a significant number of injuries.

1146 ▪ LDZ damage may extend to ~3 miles from ground zero for a 10 kT nuclear explosion. Damage in this
1147 area will vary, because shock waves will rebound off buildings, terrain, and the atmosphere.

1148 **Blast**

1149 ▪ The blast will damage unreinforced structures and cause injuries. Most injuries are not life-
1150 threatening, and self/outpatient care may be adequate.

1151 **Radiation**

1152 ▪ For near-surface detonations that generate fallout, dangerous radiation levels may exist downwind of
1153 ground zero within the LDZ. Fallout will likely take 10 minutes or more to arrive.

1154 ▪ Initial radiation is unlikely to cause significant exposure (even to those outside), except for yields less
1155 than 1 kT.

1156 **Thermal**

1157 ▪ For air bursts and yields greater than 10 kT, the thermal pulse can ignite fires and cause lethal burns to
1158 those with a line-of-sight to the fireball in the portion of the LDZ closest to the detonation.

1159 ▪ Fires will be a major concern in the LDZ. Depending on weather conditions, MDZ fires can quickly
1160 spread into the LDZ and may coalesce into a firestorm.

1161 **EMP**

1162 ▪ Most battery-operated equipment will not be damaged, but some equipment may lose some
1163 functionality. Battery-operated equipment should work after power cycling (turning off, then on again).

1164 ▪ Equipment plugged into wall outlets without a surge protector may be damaged due to power surges.

1165 ▪ Commercial band AM/FM radios will continue to receive signals from transmitters outside the area.

1166 ▪ Power will likely be out in most, if not all, of the LDZ, due to power grid destabilization.

1167 **Public actions:** Seek adequate shelter in basement areas or the center of larger concrete or reinforced
1168 brick buildings. There will be 10 minutes or more after the detonation to find adequate protection before
1169 fallout arrives. Stay sheltered 12-24 hours unless provided alternate instructions or if you are in
1170 immediate danger from fire, building collapse, medical emergency, or other imminent threat.

1171 **Responder actions:** Treat survivors with serious injuries and direct patients with minor injuries to triage sites.
1172 Support response efforts in the MDZ. Monitor radiation levels and avoid the DRZ.

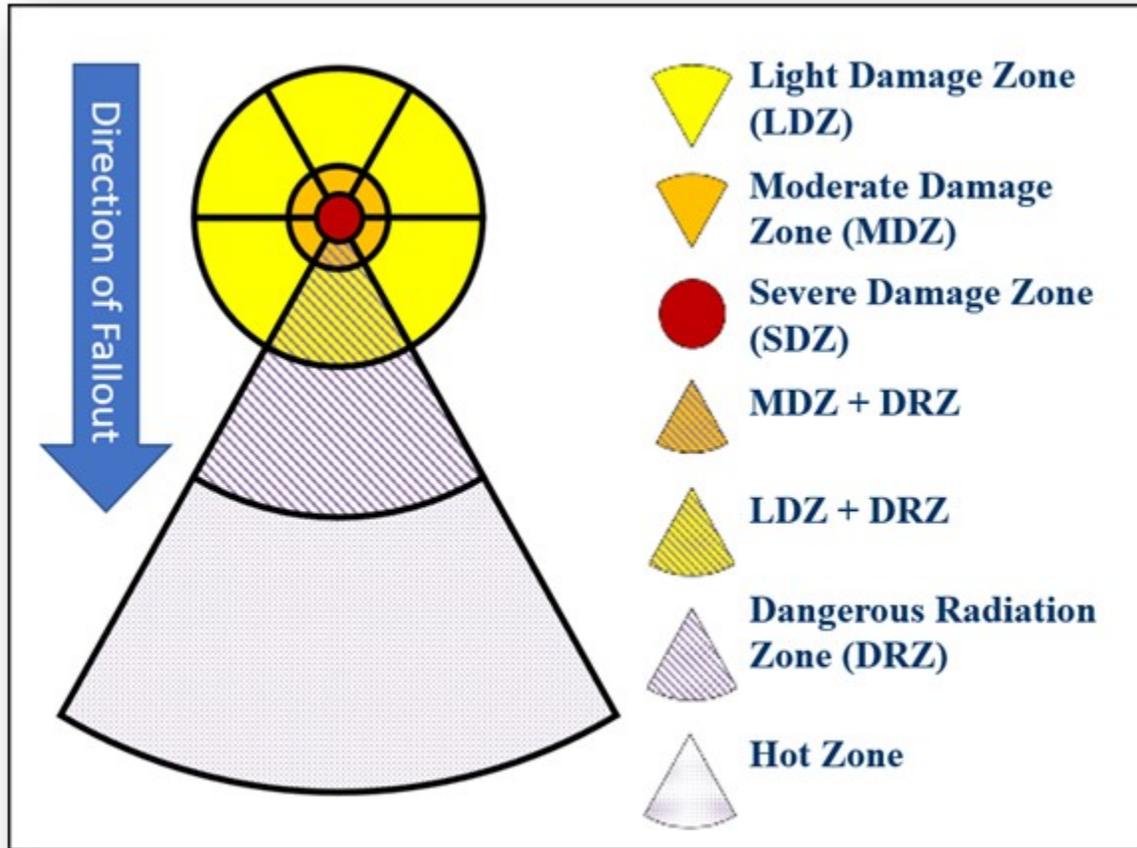
1173 ▪ **LDZ Outside of the DRZ (i.e., exposure rate less than 10 R/h): Manage fires, clear routes, and advise**
1174 **shelter, but do not prevent self-evacuation.** Evacuation is not required to mitigate the radiological
1175 hazard but may be warranted due to unsafe shelter conditions (weather, fire, medical emergency,
1176 smoke, etc.). Responders should maintain evacuation corridors and treat the injured. If elevated
1177 radiation levels (i.e., HZ) occur, keep people moving out of the contaminated area. Identify casualty
1178 collection points and Radiation Triage and Treatment (RTR) 1 sites (For information on RTR sites, visit
1179 Chapter 4.

1180 ▪ **LDZ with DRZ Overlap (i.e., exposure rate greater than 10 R/h): Manage fires (if needed to prevent**
1181 **spread) and recommend sheltering if safe to do so. Minimize outdoor responder activities. Monitor**
1182 **radiological conditions and operate outside the DRZ when possible.** Only conduct short, focused,
1183 critical activities in the DRZ. Defer all non-immediate response needs. If fire suppression is needed in
1184 the DRZ, consider approaches that don't require the physical presence of responders (e.g., helicopter
1185 techniques).

1186 **Additional LDZ information:**

- 1187 ▪ The uninjured and those with minor injuries should seek adequate shelter.
- 1188 ▪ Crashed vehicles will block roads, preventing or slowing emergency vehicle access.
- 1189 ▪ Where safe to do so, self-treatment and community-organized first aid (such as RTR 1 sites described
1190 in Chapter 4) should be promoted in this zone.

1191 Most of the injuries incurred within the LDZ will not be life-threatening. If injured survivors are mobile,
1192 they should be directed to RTR sites (see Chapter 4).



1193

1194

Figure 23: Simplified hazard zone template usable for planning or early response purposes.

1195

2. Emergency Worker Safety

1196

The National Council of Radiation Protection and Measurement (NCRP) defines Emergency Workers as those who would be called to assist with response to a radiological or nuclear incident, acknowledging that most emergency workers have jobs that do not routinely expose them to significant radiation.²¹ Emergency workers include law enforcement personnel, firefighters, emergency medical service providers, and infrastructure repair personnel, among others.

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To manage emergency worker safety, incident response organizations should adhere to the National Incident Management System (NIMS) and Incident Command System (ICS). At all levels of government, the ICS is the emergency response standard, and facilitates safe operations in highly hazardous environments.

1202

1203

²¹ This definition is derived from NCRP Report No. 179, *Guidance for Emergency Response Dosimetry*, and reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

1204 IMAAC can provide models indicating fallout deposition and dangerous radiation areas within the first hour
1205 after a nuclear detonation. IMAAC models are available to FSLTT authorities²². As described in Chapter 1,
1206 initial products are only estimates and will likely have great uncertainty about affected areas, but accuracy
1207 will improve over time.

1208 Predictive modeling alone is not sufficient for making worker protection decisions. Radiation
1209 measurements and fallout cloud observations are critical to confirm fallout affected areas and make
1210 informed protective action decisions.

1211 Radiation measurements and zone awareness are the primary measures to limit and avoid radiation
1212 exposure. Emergency worker dose can be monitored and controlled in a variety of ways, including
1213 worker accountability practices and stay time limits.²³

1214 **2.1. Emergency Worker Safety Strategy**

1215 An emergency worker safety program must be integrated into overall operational planning. Emergency
1216 worker safety programs must review operational tasks, analyze hazards posed to workers, and establish
1217 necessary protections. First responders cannot be expected to have radiological expertise, yet in the
1218 context of an emergency they must plan and manage response activities that involve radiation exposure.
1219 Under emergency conditions, applying ALARA can be viewed as making reasonable and practical efforts to
1220 both maintain radiation exposures below levels causing acute health effects and to reduce the risk of
1221 stochastic effects (i.e., risk of cancer later in life), as to maximize life-saving operations and protect critical
1222 infrastructure.

1223 Emergency worker safety programs should adopt dose guidelines for “emergency exposure situations
1224 where an informed, exposed individual is engaged in volunteered life-saving actions or is attempting to
1225 prevent a catastrophic situation.”²⁴ These guidelines are not limits—rather, they identify conditions where
1226 higher doses may be justified. Once urgent, life-saving actions are no longer required, appropriate
1227 regulatory limits should be applied. Emergency responder guidelines can be found in Table 4.

²² For information about how to access and request IMAAC products, please visit this page: [IMAAC Info](#).

²³ Derived from NCRP Commentary No. 19, *Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism*, and reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>

²⁴ Paragraph 247 of ICRP 103.

1228

Table 4: Responder dose guidelines²⁵

| Guideline | Activity | Condition |
|-------------------------------|---|---|
| 50 mSv (5 rem) | All occupational exposures | All reasonably achievable actions have been taken to minimize dose. |
| 100 mSv (10 rem) ^a | Protecting valuable property necessary for public welfare | Exceeding 50 mSv (5 rem) is unavoidable and all appropriate actions are taken to reduce dose. Monitoring available to project or measure dose. |
| 250 mSv (25 rem) ^b | Lifesaving or protection of large populations | Exceeding 50 mSv (5 rem) is unavoidable and all appropriate actions are taken to reduce dose. Monitoring available to project or measure dose. |
| >250 mSv (>25 rem) | Lifesaving or protection of large populations | All conditions above and only for people fully aware of the risks involved |
| 500 mGy (50 rad) | Lifesaving or protection of large populations | NCRP recommends, when the cumulative absorbed dose to an emergency responder reaches 0.5 Gy (50 rad), a decision be made on whether to withdraw the emergency responder from the HZ. NCRP considers the 0.5 Gy (50 rad) cumulative absorbed dose a decision dose, not a dose limit. |

1229 ^a For potential doses > 50 mSv (>5 rem), medical monitoring programs should be considered.

1230 ^b In the case of a very large incident, such as an improvised nuclear device (IND), incident commanders may need to
 1231 consider raising the property and lifesaving response worker guidelines to prevent further loss of life and massive
 1232 spread of destruction.

1233 The PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents advises
 1234 exposures below 50 mSv (5 rem) for worker protection whenever possible. However, when there is an
 1235 overwhelming and immediate need, additional guidelines may be considered.

1236



Refer To

1237 [PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents:](https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf)
 1238 [https://www.epa.gov/sites/production/files/2017-](https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf)
 1239 [01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf](https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf)

1240 The NCRP defines decision points, as “when the cumulative absorbed dose to an emergency
 1241 responder reaches 50 rad, a decision must be made on whether or not to withdraw the emergency

²⁵ This table is adapted from NCRP Commentary No. 19, *Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism*, and reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

1242 responder from the HZ. NCRP considers the 0.5 Gy (50 rad) cumulative absorbed dose a decision
1243 dose, not a dose limit.”²⁶



Refer To

1244 [Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers:](https://ncrponline.org/wp-content/themes/ncrp/PDFs/2017/NCRP_Report_No.165_complimentary.pdf)
1245 [https://ncrponline.org/wp-](https://ncrponline.org/wp-content/themes/ncrp/PDFs/2017/NCRP_Report_No.165_complimentary.pdf)
1246 [content/themes/ncrp/PDFs/2017/NCRP_Report_No.165_complimentary.pdf](https://ncrponline.org/wp-content/themes/ncrp/PDFs/2017/NCRP_Report_No.165_complimentary.pdf)
1247



Action Item

1248 Develop and disseminate a comprehensive emergency worker safety program for nuclear
1249 incident response.
1250

1251 2.1.1. EMERGENCY RESPONSE DOSIMETRY

1252 The first 72 hours after a nuclear detonation will be a period of austere conditions when some emergency
1253 workers will not be fully equipped to measure and control their radiation dose. This will be a chaotic time
1254 and public health and safety agencies may be forced to adapt or modify their routine practices and
1255 expectations. While exceptions may be necessary in the earliest phase of response, controlling the first
1256 responder and emergency workers exposures is critical.

1257 Emergency worker dose assessments can be performed in a variety of ways with a variety of equipment or
1258 techniques.²⁷

1259 “Dosimetry is defined as the science or technique of determining radiation dose. Strictly speaking,
1260 involving measured quantities, but also used informally to mean “dose assessment” (i.e., involving
1261 measurements and/or theoretical calculations).”²⁸

²⁶ This is derived from NCRP Report 179, *Guidance for Emergency Response Dosimetry*, with permission from the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

²⁷ Derived from NCRP Report No. 179, *Guidance for Emergency Response Dosimetry*, and reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

²⁸ Derived from NCRP Report No. 179, *Guidance for Emergency Response Dosimetry*, and reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

1262 **2.1.2. RADIATION DETECTION AND MONITORING INSTRUMENTATION**

1263 When responding to a nuclear detonation, responders need an instrument that alerts users of hazardous
1264 radiation levels and accumulated exposures. There are a variety of radiation detection and monitoring
1265 instruments, designed for various work environments and levels of radiation likely to be encountered.
1266 Appendix 2.1 provides additional information on the appropriate selection of equipment and their
1267 limitations.

1268 **2.1.3. ASSIGNING A DOSE TO EMERGENCY WORKERS**

1269 Assigning a dose to an individual does not require specific equipment or devices, but it should be based
1270 on the best obtainable information. Alternate techniques for determining radiation dose include monitoring
1271 and dose reconstruction:

- 1272 ▪ Monitoring: Using radiation detectors that provide real-time radiation exposure rates and, where
1273 possible, cumulative exposures.
- 1274 ▪ Dose Reconstruction: Retrospective dose assessment based on representative individuals/populations.

1275 Alternate techniques for determining emergency worker dose are discussed in Appendix 2.1: Alternative
1276 Techniques to Determine Dose.

1277 With proper planning, emergency worker dose control and monitoring can be adequately performed
1278 with older, less-capable equipment and repurposed preventative radiological/nuclear detectors.

1279 Monitoring dose rates and tracking time and location information for each emergency worker can often
1280 suffice as basic emergency worker dosimetry.

1281 **2.1.4. PERSONAL PROTECTIVE EQUIPMENT (PPE)**

1282 External exposure from penetrating radiation is the primary hazard, as opposed to inhalation or ingestion.
1283 Penetrating radiation can penetrate through clothing, walls, protective suits, cars, etc. Based on
1284 observations from past nuclear weapon tests, respiratory protection is not generally required to address
1285 fallout hazards (Levanon, 1988). Respiratory protection should be selected based on non-radiological
1286 hazards, such as smoke, dust, or vapors.

1287 Typical HAZMAT protection, like protective suits and respiratory protection, do not mitigate penetrating
1288 radiation. Bulky PPE may even increase responder doses because it may slow responders down, increasing
1289 the time needed to accomplish the mission and exposing them for longer periods.

1290 PPE selection should be based on the non-radiological hazards (fires, toxic industrial chemicals, sharp
1291 debris, etc.) in damage zones. For the radiological hazard, the most important equipment is a radiation
1292 detector that alerts workers to radiation levels of concern.

1293 The National Institute of Occupational Safety and Health (NIOSH) prepared guidance on selecting
1294 appropriate PPE for response to terrorism incidents involving CBRN incidents. Effective advanced planning

1295 must ensure that the emergency workers have access to the appropriate PPE for the activities they are
1296 performing during the response.



Refer To

1297

1298 [Guidance on Emergency Responder Personal Protective Equipment \(PPE\) for Response to CBRN](https://www.cdc.gov/niosh/docs/2008-132/pdfs/2008-132.pdf)
1299 [Terrorism Incident: https://www.cdc.gov/niosh/docs/2008-132/pdfs/2008-132.pdf](https://www.cdc.gov/niosh/docs/2008-132/pdfs/2008-132.pdf)

1300 Firefighter turnout gear and anti-contamination clothing can ease decontamination, but time-critical, life-
1301 saving activities should not be delayed if such items are not available (assuming other hazards at the
1302 scene do not require such PPE). Following a nuclear detonation, many non-radiation hazards will be
1303 present. Fires, toxic industrial chemicals, and sharp debris are just a few examples of hazards that should
1304 be considered when working in the SDZ, MDZ, and LDZ.

1305 3. Critical Infrastructure Decontamination

1306 In the early response phase, infrastructure decontamination should be limited to infrastructure necessary
1307 to accomplish lifesaving missions and stabilize Community Lifelines. The Community Lifelines are a FEMA
1308 framework representing a core set of services fundamental to community function. There are seven
1309 Community Lifelines—Safety and Security; Food, Water, Shelter; Health and Medical; Energy (Power & Fuel);
1310 Communication; Transportation; and Hazardous Materials. Community Lifeline services and components
1311 include healthcare facilities, power plants, water treatment plants, airports, bridges, and evacuation routes.
1312 For a community to recover from a radiological or nuclear incident, all Community Lifeline components
1313 must be stabilized, including any necessary decontamination. Contaminated infrastructure should be
1314 prioritized based on estimated radiation exposure rates, to determine if postponing decontamination is
1315 preferable. For more critical infrastructure decontamination information, see Appendix 2.2:
1316 Decontamination of Critical Infrastructure.



1317

1318 **Figure 24: FEMA's community lifelines represent a set of core services necessary for community**
1319 **function.**



Refer To

1320

1321 The Community Lifelines Toolkit explains the seven different lifelines and their subcomponents,
1322 highlighting key infrastructure to consider during emergency response.

1323 <https://www.fema.gov/sites/default/files/2020-05/CommunityLifelinesToolkit2.0v2.pdf>

1324 4. Waste Management

1325 Following the detonation, an enormous quantity of contaminated, HAZMAT, and uncontaminated waste will
1326 be generated. Nuclear incident response plans must include waste management priorities and guidelines to
1327 address this waste. FSLTT waste management personnel should be involved in planning and response
1328 activities, to identify holding/storage areas early in response. Officials must assess their local waste
1329 management asset inventory to support immediate recovery efforts. Waste staging and holding location
1330 plans must extend beyond debris segregation and storage, to include screening debris for human
1331 remains, ensuring site security, assessing environmental and human health impacts, etc. For more
1332 information on waste management planning, see Appendix 2.3: Waste Management Options.



1333 Action Item

1334 Include waste management priorities, methods, and inventory in nuclear incident response
1335 plans.

1336 Plan for decontamination of critical infrastructure and waste management operations to support
1337 extended response activities.



1338 Refer To

1339 Planners and emergency response officials must work with waste management personnel in their
1340 district when planning and responding.

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Chapter 3: Shelter & Evacuation

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Sheltering is one of the most, if not the most, important protective action that affected populations can take in the first few hours after a nuclear explosion. Sheltering can save lives by protecting people from radioactive fallout and the inhalation of dust and smoke. To assist people in rapidly sheltering, planners must publicize shelter criteria, identify mass care shelters, and develop key messages. Following a nuclear detonation, the primary goal of sheltering and evacuation is to reduce the number of people exposed to life-threatening situations, such as high levels of radiation, medical emergencies, and fires.

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A nuclear detonation creates many simultaneous hazards, as noted in Chapter 1. When faced with multiple, competing hazards, priority should be given to immediate, rather than longer term, threats. As a practical example, even in the DRZ people should leave a burning building. This guidance accepts that the risk of delayed health effects (due to radiation exposure) is lower than the risk of immediate death (due to the fire).

1354

At the strategic level, a combined shelter and evacuation strategy has four steps:

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1358

1. Initially shelter (Get Inside, Stay Inside, Stay Tuned). In the absence of any information, sheltering provides protection against initial and fallout radiation, blast, thermal, and dust/smoke hazards. It also reduces the strain on response organizations and transportation infrastructure to better allow responders to access and manage the incident.

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2. Develop situational awareness. Actions taken in the first few hours will have the biggest impacts on the overall number of lives saved. As such, prioritize identifying the following:

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- a. The response zones discussed in Chapter 2.
- b. People in life-threatening situations such as fire concerns, medical emergencies, poor shelter quality in the DRZ, and building structural issues.
- c. Potential evacuation routes and evacuation support capabilities.

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3. Focus early (<24hr) response actions on immediately life-threatening situations, such as:

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- a. Establishing and maintaining evacuation corridors in high threat areas.
- b. Fire control / suppression in areas where people are sheltered.
- c. Evacuating people in areas where immediate threats outweigh evacuation hazards.
- d. Buildings in the DRZ with adequate shelter.

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4. As time allows (greater than 24 hr), replace shelter with other response actions—Shelter is inherently a short-term response. End shelter when it is safe to do so. Evacuate people located in places where hazardous conditions remain, such as the MDZ. Consider simply lifting the shelter-in-place order where the hazardous conditions no longer remain (e.g., outside the HZ) and general population movement does not otherwise hinder the response.

1375 1. Timely Messaging

1376 Officials issuing warnings may only have 15-30 minutes involving a ballistic missile attack. A nuclear
1377 detonation by a terrorist group may have no warning.

1378 Incidents may occur without advanced notice. Planners must ensure that as much of the sheltering plan as
1379 possible is prepared ahead of time.

1380 Protective actions must be developed, communicated, and implemented quickly, to enhance their life-
1381 saving capabilities. Delays in issuing and implementing recommendations could result in unnecessary
1382 fatalities. Messaging guidance is described more in Chapter 6 and alerts, warnings, and notifications in
1383 Chapter 7.

1384 The following guidelines are provided for planning purposes, to identify planning and resource needs.

- 1385 ▪ Initial projections of fallout deposition should be communicated to responders as rapidly as possible;
1386 preferably within the first hour and updated every hour.
- 1387 ▪ Initial recommendations should be communicated to the public as rapidly as possible (see Chapter 6
1388 for more information).
- 1389 ▪ Staged/phased evacuations or relocations should begin, where appropriate, within 24 hours depending
1390 on estimated radiation exposure of the subject population, logistics, and other factors.



1391 Action Item

1392 Prepare and approve emergency messaging prior to incidents to ensure swift dissemination of
1393 important information.

1394 2. Adequate Shelter

1395 As used in this document, to ‘Take Shelter’ or ‘Get Inside’ means going in (or staying in) the nearest
1396 underground or enclosed structure. An ‘adequate shelter’ is a location that is heavy enough construction
1397 (e.g., concrete, brick, or cement) to mitigate blast effects (if sheltering prior to detonation) and reduce
1398 radiation exposure from fallout by a factor of 10 or more.

1399 The best initial action immediately following a nuclear explosion is to take shelter in the nearest and
1400 most protective facility and listen for instructions from authorities.

1401 Adequate shelter facilities for nuclear explosions must meet the following criteria:

- 1402 ▪ **RADIATION:** Shelter location is underground or comprised of dense materials (e.g., concrete, brick, or
1403 earth/underground).

- 1404 ○ Above ground rooms located in the middle of the building, away from outside walls and roof.
- 1405 ○ Underground areas such as basements, subway tunnels, underground parking garages.
- 1406 ■ **BLAST:** Underground areas or the center of building that have heavy construction (concrete, brick, or
1407 cement) to mitigate blast effects. Protection from blast effects is not the primary purpose of sheltering,
1408 as populations may not have time to seek shelter from these effects but is important to consider
1409 ensuring shelters are structurally sound.
- 1410 ■ **DUST AND SMOKE:** Minimize the amount of outdoor air being drawn into the building. Make sure to
1411 maintain enough ventilation to ensure adequate indoor air quality.



Refer To

1412
1413 [The Effect of Nuclear Weapons: https://www.dtra.mil/Portals/61/Documents/NTPR/4-
Rad_Exp_Rpts/36_The_Effects_of_Nuclear_Weapons.pdf](https://www.dtra.mil/Portals/61/Documents/NTPR/4-
1414 Rad_Exp_Rpts/36_The_Effects_of_Nuclear_Weapons.pdf)

1415 To protect against radiation fallout:

- 1416 ■ Reduce time spent in radioactive areas
- 1417 ■ Increase distance from source of radiation (fallout)
- 1418 ■ Use dense materials (e.g., concrete, brick, or earth) as shielding



Action Item

1419
1420 When developing sheltering plans and guidance, evaluate adequate shelters and identify areas
1421 where few are available. If feasible, target these areas of shelter improvement or develop plans
1422 for rapid evacuation.

1423 For sheltered individuals, the likelihood of acute radiation injury depends on both the outdoor radiation
1424 dose rate and the structure's protection factor (degree to which the dose is reduced, larger values provide
1425 better protection). Even minimally protective shelters outside the DRZ may be sufficient

1426 Penetrating radiation can be mitigated with shielding (placing dense building materials between people
1427 and radiation sources such as fallout) and increased distance from deposited fallout, including fallout on
1428 roofs. Adequate shelters reduce radiation doses by a factor of 10 or more and examples include
1429 basements; centers of large, multi-story structures; parking garages, and tunnels. Cars and other vehicles
1430 are not adequate shelters because they lack dense shielding material. Good shielding materials include
1431 concrete, brick, stone, and earth. Wood, drywall, and thin sheet metal provide minimal shielding. However,
1432 many layers of minimal shielding materials can also provide adequate protection (e.g., central rooms with
1433 many intervening drywalls). Structures do not need to be airtight to protect against fallout radiation, so
1434 buildings with minor damage can be used as shelters if they are structurally sound.

1435 Shelters such as houses with basements, large multi-story structures, and parking garages or tunnels
1436 can generally reduce doses from fallout by a factor of 10 or more.

1437 Vehicles and single-story wood frame houses without basements provide limited shielding and should
1438 not be considered adequate shelter.

1439 3. Sheltering Guidance

1440 The best initial action following a nuclear explosion is moving to and remaining within an accessible,
1441 adequate shelter away from windows, corners, doors, and outside walls. Individuals should plan to remain
1442 sheltered for at least 12-24 hours.

1443 In the first few minutes after the detonation, being outdoors may result in death, severe burns, severe
1444 lacerations, and/or bone fractures due to blast overpressure and thermal hazards. The risk of these
1445 injuries increases with proximity to ground zero.

1446 In the first few hours, lethal radiation levels may be present – even in areas 10s of miles from ground
1447 zero and/or where fallout is not apparent. The hazard of the fallout radiation will decrease significantly over
1448 time, enabling safer evacuations. For additional sheltering protective action information, see 3.1: Shelter
1449 Protective Actions. Emergency response officials may issue supplemental orders, such as early evacuation,
1450 to people in structures with poor shielding, e.g., wood frame residential structures. In addition, these
1451 individuals can reduce their radiation dose by transitioning to adequate shelters in the nearby area, ideally
1452 moving away from ground zero. The optimal time, from detonation, to stay in the first (poor quality) shelter
1453 will depend on the initial shelter protection factor and the travel time to the adequate shelter. The initial
1454 shelter time does not depend on the local radiation levels. When adequate shelters are nearby (within 15
1455 minute travel time), people in poor quality shelters (protection factors = 2) should stay there no longer than
1456 30 minute from the detonation. For individuals in better shelters (protection factor = 4), people should stay
1457 for an hour or two prior to moving to a nearby adequate shelter.

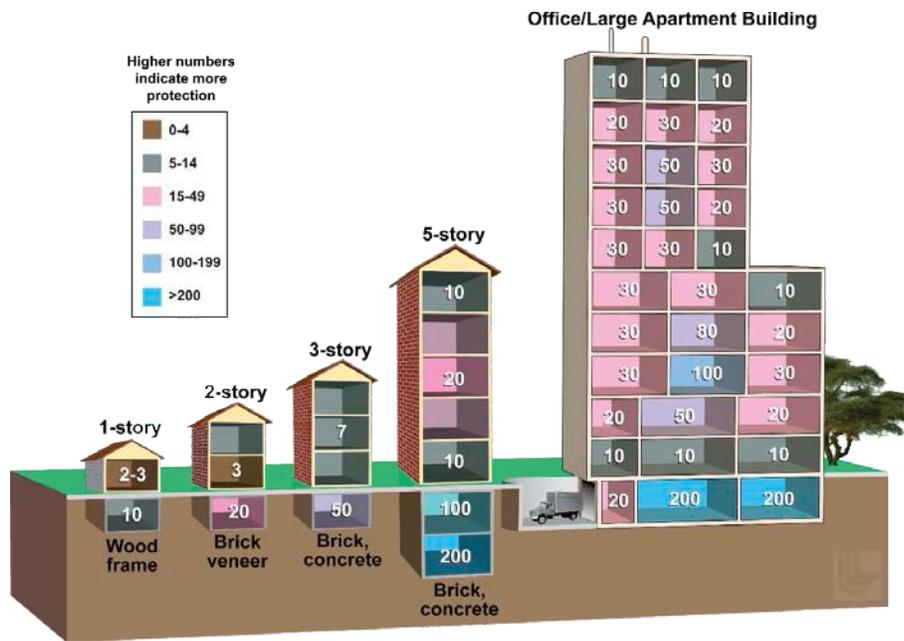
1458 Planners should evaluate adequate shelter options in their area. Planners must consider areas where
1459 adequate shelter is not readily available and develop alternative shelter options for those areas, including
1460 information and awareness messaging, evacuation plans, and self-protection measures. Planners in
1461 communities that generally lack adequate shelters should implement a public shelter program that
1462 provides adequate shelter. For example, in regions where residential basements are uncommon, planners
1463 must pre-designate large buildings as public shelters.

1464 What Would You Do?

1465 Put yourself in the shoes of someone in your jurisdiction who has been asked to shelter: How long
1466 could you comfortably shelter at home or your workplaces? How long until you ran out of basic
1467 resources, medication, etc.? How do the answers to these questions affect your response plan?

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Figure 25 illustrates the radiation exposure reduction based on building type and location within the building.



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Figure 25: Buildings provide protective fallout shielding – Numbers represent a building protection factor. A building protection factor of 10 indicates that a person in that area would receive 1/10th of the dose of a person in the open. A building protection factor of 200 indicates that a person in that area would receive 1/200th of the dose of a person out in the open.

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Action Item

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- 1477 ▪ Address firefighting concerns in nuclear incident plans, including a prioritization structure for
1478 potentially limited water resources.
- 1479 ▪ When planning evacuation routes, ensure the routes do not obstruct critical transportation
1480 routes or response operations at large.

1481 4. Situational Awareness

1482 The zoned based approach described in Chapter 2 is the foundation for shelter and evacuation decisions.
1483 Planners must consider what resources are necessary to obtain accurate estimates of the fallout
1484 distribution and the building status to define these zones. Since each information source only provides a
1485 partial characterization, planners should continuously incorporate new resources and information as they
1486 become available. It is critical to monitor for evolving hazards such as fallout deposition and fire initiation,
1487 spread, and possible coalescence.

1488 Accurate fallout distribution and radiation dose rate estimates are critical for safe evacuations so that
1489 evacuees do not evacuate through locations with higher dose rates. Radiation monitoring data from local
1490 responders can contribute to the situational awareness. Plume models, such as IMAAC's products, can
1491 project hazardous areas based on available information and parameters. Prediction accuracy will improve
1492 as measurements become incorporated into the models. Visual observations of the fallout cloud and its
1493 downwind drift can also be helpful. Fallout particles may be visible as fine, sandy material actively falling
1494 out as the plume passes or accumulating on clean surfaces, see Fig 1.10. Visible fallout particles may not
1495 be noticeable on rough or dirty surfaces, so their presence, or absence, cannot be used to directly estimate
1496 radiation dose rates.

1497 After a nuclear detonation, the heat from the blast will ignite flammable and combustible materials— such
1498 as fuel, gas lines, furniture, and structural materials—particularly in the MDZ. Additionally, water and
1499 power outages due to the blast will inhibit firefighting capabilities. Thus, uncontrolled fires are anticipated
1500 and may spread from building to building, or house to house.



Action Item

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1502 Ensure plans include methods and processes for obtaining fallout projections. Exercise this
1503 process as necessary.



Coordination Opportunity

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1505 SLTT response officials must coordinate with federal entities to request fallout projections and
1506 protective action recommendations.

1507 5. Evacuation Guidance

1508 Sheltering is implicitly short term. Initial sheltering should be followed by staged, facilitated evacuation for
1509 those in fallout-impacted areas. Optimal shelter stay times can range from a couple hours to several days
1510 and depends both on the local fallout dose rate and the radiation dose incurred during evacuation. Where
1511 possible, individuals should stay in an adequate shelter for the first 24 hours following detonation to
1512 prevent exposure to high levels of radiation. Evacuations should occur only after appropriate paths have
1513 been identified and cleared. Fire concerns should be closely monitored as rapidly evolving fires may
1514 warrant emergency evacuation of potentially impacted areas. Attempting to evacuate excessively large
1515 areas at a single time unnecessarily diverts resources from other response needs. Be aware that many
1516 people may choose to self-evacuate.



Action Item

1517

1518 When planning evacuation routes, ensure they do not obstruct critical transportation routes or
1519 response operations at large.

1520 Unless threatened by fire or other immediate life safety concerns, no evacuation should be attempted
1521 until basic information is available regarding fallout distribution and radiation dose rates.

1522 When evacuations are executed, the priority should be to minimize the overall dose received. In many
1523 cases, travel should be at right angles to the fallout path (to the extent possible) and away from the
1524 plume centerline, sometimes referred to as lateral evacuation.

1525 Evacuations should be prioritized based on fallout patterns, radiation dose rates, shelter adequacy, life-
1526 threatening hazards (e.g., fire and structural collapse), medical needs, needs of special populations such
1527 as children or pregnant women, sustenance resources (e.g., food and water), and operational
1528 considerations. Planners should especially prioritize individuals who face immediately life-threatening
1529 situations. For these groups, early evacuation (starting less than 24 hours after the detonation) may be
1530 necessary. Uninjured individuals with adequate shelters are a low priority for early evacuation. Similarly,
1531 evacuation is a low priority for those outside of the dangerous radiation zone who have access to even
1532 minimally protective shelter (including single-story houses without basements) or for those who can quickly
1533 transition from poor to better shelters (e.g., moving from single family home to a commercial structure such
1534 as a hotel). For individuals clearly outside the DRZ and HZ, consider simply lifting the shelter-in-place order
1535 (i.e., no evacuation) when appropriate.

1536 When planning any evacuation, planners must consider:

- 1537 ▪ Responder and evacuee risks, including radiation exposure along the evacuation route
- 1538 ▪ The threat of fires or hazardous material exposure in the area
- 1539 ▪ Transportation resources (e.g., vehicles, public transit, rail, air, water)
- 1540 ▪ Ease of access and egress (including infrastructure damage to roads, bridges, and tunnels)
- 1541 ▪ Evacuation support resources
- 1542 ▪ Impact of self-evacuated populations

1543 6. Self-Evacuation

1544 Responders will have limited control of the evacuation process immediately following a detonation, due to
1545 access limitations and fallout hazards.

1546 Many individuals may self-evacuate, based on either official guidance or uninformed, spontaneous
1547 decisions. Self-evacuation is strongly discouraged due to the risks involved and because self-evacuees may
1548 clog transportation arteries, hindering the overall response. However, guidance should be provided to those
1549 who choose to self-evacuate despite warnings. Assistance may include providing self-evacuation
1550 instructions, including what direction to travel and when to go, as well as route conditions (e.g., rubble and
1551 debris in streets, collapsed bridges, and other obstacles). Self-evacuation guidance should also emphasize
1552 circumventing critical operations, when possible, to avoid complicating necessary evacuations and other
1553 response operations. Law enforcement can assist in keeping evacuations moving smoothly and protecting

1554 key infrastructure, including medical care centers that may otherwise be overwhelmed by self-reporting
1555 patients.



Action Item

1556

1557 Anticipate self-evacuations regardless of guidance. Provide guidance specifically for those self-
1558 evacuating.



Coordination Opportunity

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1560 Consider incorporating law enforcement into evacuation plans. Law enforcement can direct traffic
1561 and ensure critical infrastructure, such as health facilities, are not overwhelmed.

1562 7. Contamination Concerns

1563 Contamination occurs when fallout lands on clothing and exposed parts of the body (head, hands, etc.). It
1564 could also occur when moving through contaminated areas. Inhalation or ingestion of fallout is not a
1565 primary concern during the emergency phase of the response because of the large size of the fallout
1566 particles and their rapid decay. Crude respiratory protection, such as a cloth mask can further mitigate any
1567 concern. People may need rudimentary decontamination when they leave fallout areas or enter a shelter.
1568 Effective decontamination of people from fallout can be accomplished by brushing, removing, or changing
1569 the outer layer of clothing and wiping off exposed skin. For more information regarding contamination
1570 screening and decontamination, see Chapter 5.

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Chapter 4: Acute Medical Care

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The large number of casualties caused by a nuclear detonation will likely overwhelm all local infrastructure, including local medical systems. Depending on the location of the detonation, tens or hundreds of thousands of people may require immediate lifesaving care and millions more may need some level of medical attention. Nevertheless, [training and planning](#) can save lives and prevent suffering.

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Refer To

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Numerous organizations provide relevant training, including:

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- [Center for Disease Control and Prevention \(CDC\)](#)

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- [Center for Domestic Preparedness \(CDP\)](#)

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- [Counter Terrorism Operations Support \(CTOS\)](#) Center for Radiological/Nuclear Training

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- [Department of Health and Human Services \(HHS\)](#)

1582

[Radiation Emergency Assistance Center/Training Site \(REAC/TS\)](#) The injuries seen will vary by location within the damage zones and fallout zones, with more severe injuries seen in the SDZ and MDZ than in the LDZ or in the parts of the HZ/DRZ which are outside of the damage zones. Much of the lifesaving work in the aftermath of the detonation involves finding and treating people who suffer injuries that are severe enough to lead to death without treatment but are likely to recover with even basic treatment. This population is proportionally largest in the MDZ, though depending on specific location of the detonation may be numerically bigger in the LDZ. Planners should work with federal agencies to understand the specific numbers of people that may fall into each category for their own jurisdiction under different scenarios.

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Following a nuclear detonation, three major injury types are expected:

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- Mechanical (physical) trauma

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- Thermal burns

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- Radiation injuries, including both cutaneous radiation injury (e.g., radiation burns) and acute radiation syndrome, both of which are discussed in greater detail in this chapter

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These injuries can occur alone or in combination. [Combined injuries, defined as radiation injury in addition to thermal burns and/or mechanical trauma](#), have a worse prognosis than simply adding the prognosis from each injury alone. Casualty triage for scarce resource environments typically prioritizes mechanical injury, then thermal burns, then radiation injuries. In the DRZ, where there is little mechanical or thermal injury, estimates of radiation exposure are triaged promptly.

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Following a nuclear detonation, mass medical care efforts will focus on identifying and treating radiation injuries, called acute radiation syndrome (ARS), that results from [external exposure](#). Medically significant

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1603 external exposure will affect more people and cause much more morbidity and mortality than [internal](#)
1604 [contamination](#) (radioactive material inside the body from ingestion, inhalation, or absorbed through skin
1605 breaks). Planners should understand the difference between [external exposure](#), [external contamination](#),
1606 and [internal contamination](#) (see Chapter 1 for more information).

1607 Medical priorities in each of these damage zones are noted below.

- 1608 ▪ **SDZ:** Attempting to find, triage, and treat the few surviving casualties in the **SDZ** will be highly resource
1609 intensive, usually futile (i.e., casualties will be hard to find and are likely to die even with treatment),
1610 and extremely dangerous. It is not a priority in the initial days but is so as fallout decays.
- 1611 ▪ **MDZ:** To provide the most effective help to the greatest number of victims, planners and medical
1612 responders should focus **initial** medical resources on casualties in the **MDZ**. Casualties in the MDZ
1613 have acute injuries that can be helped with the resources that will be initially available. Additionally, if
1614 responders are properly monitored, they can safely access MDZ casualties. Depending on wind
1615 patterns, some parts of the MDZ will have radioactive fallout while much of the rest will not.
- 1616 ▪ **LDZ:** Most casualties in the LDZ will be minor and can be effectively treated with a delay of a few days.
1617 Those with urgent, pre-existing conditions (e.g., renal failure on dialysis) or acute medical events (e.g.,
1618 heart attacks and strokes) unrelated to the detonation that will require immediate medical attention.
1619 There may also be severe trauma injuries in the LDZ caused by car accidents secondary to flash
1620 blindness. Similar to the MDZ, parts of the LDZ may have fallout while much of the rest will not.

1621 Medical response planners should be familiar with basic medical and radiation response guidance,
1622 including:

- 1623 ▪ [ICS and Hospital Incident Command System \(HICS\)](#)
- 1624 ▪ [NRIA to the Response and Recovery FIOPs](#)
- 1625 ▪ [Radiological Emergency Medical Management \(REMM\) website](#)
- 1626 ▪ [EPA PAG](#)
- 1627 ▪ [Emergency Contacts for Help During Radiation Emergencies](#)

1628 **1. Injuries: Identification, Triage, and Treatment**

1629 Injuries faced by medical responders following a nuclear detonation primarily fall into several different
1630 categories: mechanical trauma, thermal injuries, and radiation injuries. Medical responders must be
1631 prepared to handle the complications of these injuries, including microbial infections, psychosocial, and
1632 behavioral health effects caused by the detonation. Moreover, the ongoing medical needs of the
1633 evacuating population (e.g., medically required oxygen or dialysis) of the general population must be
1634 considered while treating those injured by the incident itself.

1635 **1.1. Mechanical Trauma**

1636 Mechanical trauma will result from the blast wave, building collapse, falling/flying debris, and car
1637 accidents. Triage, diagnosis, and treatment of mechanical trauma after a nuclear detonation may differ
1638 from that practiced in normal times due to (1) radiation and burns complicating the trauma (combined
1639 injury), (2) austere conditions (scarce resources: staff, space, supplies, systems) and huge patient surge
1640 leading to alterations in standards of care, and (3) degraded infrastructure. (Coleman & Weinstock, 2011)
1641 (Hick & Coleman, 2018b)

1642 Teams composed of various specialties will manage large numbers of orthopedic, general surgery,
1643 pulmonary, cardiology, ophthalmologic, hematologic, infectious disease, neurology, and psychological
1644 issues. Referral to expert centers may be necessary when possible. Diagnosing and treating mechanical
1645 trauma requires extensive medical equipment and supplies including medical imaging equipment, supplies
1646 for wound cleaning, hemorrhage control, blood replacement, fluid replacement, pressors, antimicrobials,
1647 surgical venues, staff, and patient medical record implementation. In addition to equipment and supplies,
1648 a surge of personnel with specific expertise will also be necessary to handle the number of patients
1649 encountered, including personnel with expertise in radiation safety, infectious disease, and radiation and
1650 hematology-oncology. While functioning medical facilities will be able to support treatment of some of
1651 these injuries, the medical response plan should include the deployment of medical equipment, supplies,
1652 and personnel into receiving communities. As many with fatal traumatic injuries will die if they are not
1653 treated within twelve hours of their injury, medical response plans cannot rely solely on this deployment or
1654 the evacuation of patients. Planners should also consider bolstering the resources available at likely
1655 receiving medical centers as a preparedness effort, making more resources available after an incident.

1656 **1.2. Thermal burn Injuries**

1657 Two types of thermal injuries occur from nuclear explosions: flash burns and flame burns. Flash burns
1658 occur due to the initial thermal flash from the detonation, while flame burns result from subsequent fires.
1659 Air detonations will cause a greater number of flash burns than ground detonations, as buildings will 'shadow'
1660 the regions behind them. Thermal burns (inhalational burns in particular) also pose a hazard and
1661 significantly increase mortality when occurring alongside traumatic or radiation injury.



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Figure 26: Flash burn victims from (a) Hiroshima showing pattern burns due to clothing patterns and (b) Nagasaki showing profile burns from clothing coverage (War Department, 1945).

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Flash burns accounted for the overwhelming majority of burns sustained among survivors of Hiroshima and Nagasaki; 83-91% were due to flash alone, 6-15% were both flash and flame, and 2-3% were flame alone (Lebow & Ishikawa, 1981).

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Infections of large burns can be fatal if not debrided (detoxified or removed) within hours to days (Allgöwer & Schoenenberger, 2008). Similar to mechanical injuries, the medical response plan must be prepared to accommodate potentially large numbers of patients with burn injuries during the first few days following a nuclear detonation. Burns have a substantial requirement for continual care beyond the first treatment, as burns must be regularly debrided after the initial treatment. Like open mechanical injuries, burn wounds are also subject to infection (Church & Elsayed, 2006).

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Thermal burns are characterized both by the surface area they cover and by burn depth. Burn surface area is measured relative to the total body surface area (TBSA), designated as percent TBSA (%TBSA). For additional information about TBSA and burn depth metrics, see Appendix 4.3: Burn Injuries.

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There are currently only 139 self-identified burn centers in the U.S., with approximately 1,800 beds (American Burn Association, 2019). Even a small nuclear detonation will likely completely overwhelm the available burn beds. Planners should identify which burn centers can serve their communities and consider how to effectively include burn centers in the planning process and identify additional alternatives to support burn victims.

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Action Item

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Research nearby burn centers and identify gaps in burn treatment support. Specifically, determine how many burn beds are available.

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Coordination Opportunity

1686 Planners should coordinate with burn treatment experts to understand treatment options and
1687 identify necessary resources.

1688 1.3. Radiation Injuries

1689 Due to both the prompt radiation and a sizeable fallout zone, there will be many people with some level of
1690 external radiation exposure, external contamination, or both. External contamination can spread exposure
1691 and contaminate medical facilities and assembly centers. The vast majority of decontamination will be self-
1692 decontamination with instructions distributed by the communications experts. Those people needing
1693 medical care should be decontaminated as soon as reasonably possible; however, any immediate
1694 lifesaving procedures should be performed before decontamination. There may be many people with low
1695 exposure (<0.75 Gy) for whom decontamination is needed and possible follow-up for biodosimetry or
1696 epidemiology studies and even some with somewhat higher potential exposures who will not need
1697 immediate attention. Their physical location and medical history will help in triaging and informing those to
1698 not immediately access medical care. The symptoms of ARS are non-specific, such as nausea and vomiting
1699 given such a traumatic incident. The discussion below refers to those needing medical attention.

1700 After exposure to radiation, ARS can develop if all the following are true:

- 1701 ▪ The radiation dose from exposure was high (>0.75 Gy [>75 rad]).
- 1702 ▪ The radiation was penetrating (i.e., the energy able reach internal organs) not just superficial
1703 contamination.
- 1704 ▪ The person's entire body, or most of it, received the dose.
- 1705 ▪ The radiation was received in a short time, usually within minutes, hours, or sometimes days if the
1706 dose is high enough.

1707 While all the organs that receive a radiation dose are impacted (hence why radiation injury is a multi-organ
1708 injury) there are four classical ARS organ-based subsyndromes that develop additively, based on increasing
1709 radiation dose thresholds:

- 1710 ▪ Hematopoietic subsyndrome (H-ARS, >2 Gy [200 rad], though non-clinical effects can occur as low as
1711 0.75 Gy [75 rad]), caused by radiation injury to the red bone marrow.
- 1712 ▪ Gastrointestinal subsyndrome (GI-ARS, >5-6 Gy [>500-600 rad]) caused by radiation injury to the
1713 intestines.
- 1714 ▪ Cutaneous subsyndrome (C-ARS, >6 Gy [>600 rad]) caused by radiation injury to the skin.
- 1715 ▪ Neurovascular subsyndrome (N-ARS, >10 Gy [>1000 rad]) caused by radiation injury to the brain
1716 (Military Medical Operations, 2010).

1717 Subsyndromes are multi-system, continuous injuries that are not limited to a dose range nor are they
 1718 mutually exclusive. For example, an individual with a 6 Gy (600 rad) external radiation dose may
 1719 experience both hematopoietic and gastrointestinal (GI) subsyndromes. Similarly, at a dose of 4 Gy (400
 1720 rad), treating injury of the GI tract alongside the hematopoietic system can increase the likelihood of
 1721 recovery. The [effects of each subsyndrome are dose-dependent](#) and generally worsen with increased dose
 1722 and dose rate.

1723 Clinical effects and manifestations of ARS evolve over time, in four [successive time phases](#), listed below.

- 1724 1. Prodrome: Earliest phase of radiation injury. In this phase, medical responders will see the initial
 1725 clinical signs, symptoms, and laboratory test results. Typical symptoms include nausea, vomiting, lack
 1726 of appetite, and possibly diarrhea. Probability and severity of these symptoms increase with dose.
- 1727 2. Latent Phase: Following the prodromal phase, patients in the lower dose ranges will appear to recover
 1728 and exhibit significant symptom reduction. This phase may last from minutes to weeks, with higher
 1729 doses resulting in a shorter phase. For very high doses, this phase may not occur.
- 1730 3. Manifest Illness: This phase includes the most severe symptoms of ARS. The specific symptoms vary
 1731 with dose and subsyndrome but may include red blood cell, white blood cell, and platelet deficiency
 1732 (pancytopenia); intestinal bleeding; and peeling or fluid leakage by the skin (dry or moist
 1733 desquamation, respectively). Depending on the radiation dose and the organ(s) affected, recovery may
 1734 be followed by successive manifest illness phases. Skin, for example, may go through an initial period
 1735 of reddening (erythema) and peeling or fluid leakage (desquamation) followed by recovery, then
 1736 experience necrosis at the same site weeks or months afterward.
- 1737 4. Recovery or Death: Generally, following the manifest illness phase, an individual will either recover or
 1738 die. However, there are delayed effects of acute radiation exposure (DEARE) that can occur weeks,
 1739 months or years later. Some patients will go on to an apparently normal function and long-term
 1740 management for at-risk patients will be done in expert centers.
- 1741 5. Recognizing that whole body exposure produces multi-organ injury Table 5 below shows whole body
 1742 radiation dose ranges²⁹ and effects in smaller dose bands. For more information on the subsyndromes,
 1743 see the H-ARS section below and discussions of GI-ARS, C-ARS, and N-ARS in Appendix 4.2.

1744 **Table 5: Health Effects and Prognosis from Acute, Whole Body Exposures to Different Doses of**
 1745 **Radiation (derived from Waselenko et al., 2004)**

| Dose Range, Gy (rad) | Prodromal Phase Severity | Manifestation of Illness | Prognosis (without therapy) |
|----------------------|--------------------------|--------------------------------------|---------------------------------|
| 0.5-1.0 (50-100) | Mild | Slight decrease in blood cell counts | Almost certain survival |
| 1.0-2.0 (100-200) | Mild to Moderate | Early signs of bone marrow damage | Highly probably survival (>90%) |

²⁹ Whole body exposure refers to external exposure of the head, trunk, arms above the elbow, and legs above the knee.

| Dose Range, Gy (rad) | Prodromal Phase Severity | Manifestation of Illness | Prognosis (without therapy) |
|--|--------------------------|--|--|
| 2.0-3.5 (200-350) | Moderate | Moderate to severe bone marrow damage | Probable survival |
| 3.5-5.5 (350-550) (Often referred to as the LD50) | Severe | Severe bone marrow damage, slight GI damage | Death probable within 3.5-6 weeks (50% of victims) |
| 5.5-7.5 (550-750) | Severe | Pancytopenia and moderate GI damage | Death probable within 2-3 weeks |
| 7.5-10.0 (750-1000) | Severe | Marked GI and bone marrow damage, hypotension | Death probable within 1-2.5 weeks |
| 10.0-20.0 (1000-2000) | Severe | Severe GI damage, pneumonitis (lung tissue inflammation), altered mental status, cognitive dysfunction | Death may occur within hours; certain within 5-12 days |
| 20.0-30.0 (2000-3000) | Severe | Cerebrovascular collapse, fever, shock | Death may occur within hours; certain within 2-5 days |

1746 The distinct phases of ARS, as well as the overlapping symptoms from the different subsyndromes, can be
 1747 seen for several dose ranges in Figure 27. Depending on the dose received, symptoms may not overlap
 1748 (e.g., 1-2 Gy, where GI symptoms resolve at about the time that hematopoietic symptoms manifest). At
 1749 higher doses, symptoms may occur simultaneously. Figure 27 also shows the cyclical nature of some
 1750 radiation injuries. Following a dose of 3-4 Gy, GI symptoms manifest then subside after about two days.
 1751 Two weeks later, however, they reappear.

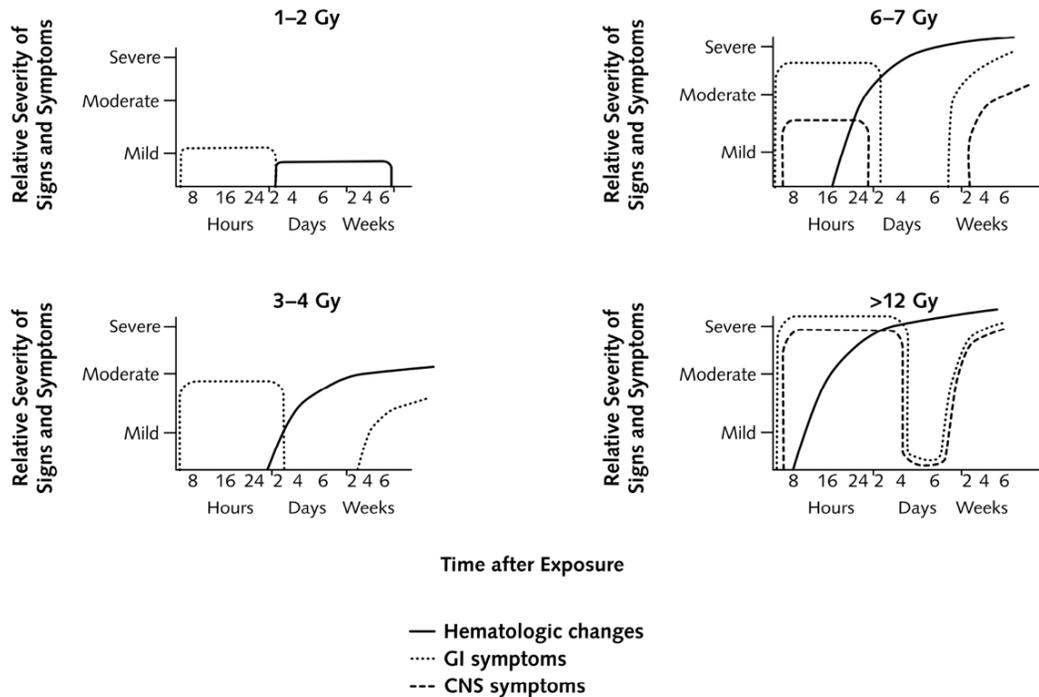


Figure 27: Relative severity of ARS symptoms of H-ARS, GI-ARS, and N-ARS over time following different doses.

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1755 Critical to discussions with patients and caregivers when offering assurance or recommendations is to
 1756 remember that radiation can also produce signs and symptoms months to years later, resulting in DEARE,
 1757 which is beyond the scope of this document (MacVittie & Farese, 2020) (MacVittie & Farese, 2019).
 1758 Regardless, awareness of DEARE and treatment of those injuries early – if possible – can mitigate or
 1759 prevent the effects before they manifest.

1760



Coordination Opportunity

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Planners should coordinate discussions between medical doctors and radiation injury treatment experts to help ensure healthcare systems understand how to identify and treat ARS and, as treatments develop, also potentially mitigate DEARE in the early stages of a response. Much research is ongoing on the underlying mechanisms of and treatment for ARS and DEARE.

1.4. Hematopoietic Acute Radiation Syndrome Prophylaxis and Management

1766 Although all the subsyndromes of ARS are important, H-ARS is particularly significant for the medical
 1767 response. H-ARS is lethal at the lowest dose, meaning that treating it will be critical to saving lives. Even for
 1768 people with much higher doses, the effects of H-ARS exacerbate the effects of other ARS subsyndromes,

1769 making treatment of H-ARS a priority. H-ARS results from damage to the hematopoietic stem cells³⁰ in the
1770 bone marrow and blood cells in circulation. Severity of H-ARS and time of onset vary based on dose, dose
1771 rate, host factors, etc. H-ARS affects [granulocytes, lymphocytes, platelets, and red blood cells](#).

1772 H-ARS problems and treatments include:

- 1773 ▪ Diagnosis and treatment of infection (antibacterial, antifungal, antiviral drugs), anemia (blood
1774 transfusions), and bleeding (platelet and blood transfusions and other countermeasures)
- 1775 ▪ Treatment of patient with cytokines to enhance production of myeloid and platelets cells
- 1776 ▪ Bone marrow (stem cell) transplant in the most severe cases, either as a bridge until the patient's
1777 marrow returns or as a complete and permanent replacement.

1778 Following a nuclear detonation, there will be severe pressure on blood banking systems and a national
1779 need to engage the limited number of specialists in hematology/oncology. The [Radiation Injury Treatment
1780 Network \(RITN\)](#) is a federally financed, U.S. organization of such specialists.

1781 White blood cell and platelet [cytokines](#) are MCMs that can significantly lessen morbidity and mortality in H-
1782 ARS patients by increasing the levels of diminished blood elements. Generally, existing US medical
1783 response plans recommend cytokine treatment for victims of nuclear detonation who received 2 gray or
1784 more whole body dose from exposure to radiation, unless those patients are triaged to the Expectant
1785 category.

1786 As of 2021, there are three Food and Drug Administration (FDA)-approved white blood cell cytokines for
1787 treating H-ARS symptoms: [Leukine](#), [Neulasta](#), and [Neupogen](#). [NPlate](#), a cytokine approved in 2008 for
1788 certain platelet disorders, was approved by the FDA in 2021 for depletion of platelets caused by radiation
1789 injury. (DiCarlo & Horta, 2019)

1790 Some cytokines can be self-administered while others require a nurse or other medical staff to administer.
1791 Cytokines are stocked in the [Strategic National Stockpile \(SNS\)](#), but additional doses may be available in
1792 user managed inventories around the country. Planners should understand how to access supplies from
1793 both sources. As cytokines will likely be short supply, at least initially, equitable and effective systems must
1794 be used to prioritize patients for cytokine administration until adequate resources arrive.

1795  **Coordination Opportunity**

1796 Planners should coordinate with medical professionals to determine what cytokines are available
1797 and understand or develop plans for regional cooperation given that much of the infrastructure
1798 outside the damage zones will be intact. Regional coordination will extend to the wide range of

³⁰ Stem cells that produce all of the blood cells, including white and red blood cells as well as platelets, among others.

1799 medical supplies. Experience from COVID-19 is relevant to planning for large-scale catastrophic
1800 incidents.

1801 H-ARS can also be treated with bone marrow transplants (infusions of hematopoietic stem cells), but they
1802 are complex, resource intensive, and expensive (Hick & Weinstock, 2011).

1803 Many of the algorithms and laboratory test systems that have been developed for diagnosing, triaging, and
1804 treating H-ARS require information about the [total dose from radiation exposure](#) received by each victim
1805 (Sullivan JM, 2013). Dose assessments will help determine decisions about triage, transport, use of
1806 countermeasures, and whether in- or outpatient management is required. Planners should be well
1807 informed about the kinds of data that can be used for dose estimation. [Some tools are available quickly
1808 and some take days to acquire, process, and report.](#) Tests and algorithms used for early triage must
1809 provide results very quickly. Frequently used options are listed below.

- 1810 ▪ Geographic dosimetry: noting where a person was located over time on the official dose maps created
1811 for the incident by IMAAC as discussed in Chapter 2.
- 1812 ▪ [Time to vomiting](#): the earlier the vomiting begins after exposure indicates a higher dose, although many
1813 other factors besides radiation can induce vomiting.
- 1814 ▪ [Lymphocyte depletion kinetics](#): faster drop in absolute lymphocyte count (from complete blood count
1815 (CBC) with differential) is associated with a higher dose from exposure.
- 1816 ▪ [Dicentric chromosome analysis](#): the greater the dose, the more chromosome damage will be observed.
1817 This test usually required days to complete.
- 1818 ▪ Other techniques are currently available, and more are under development.

1819 [REMM](#) and the [REMM mobile app](#) can estimate dose based on time to vomiting and/or absolute
1820 lymphocyte count.

1821  Refer To

1822 REMM a great resource for relevant medical information. <https://www.remm.hhs.gov/>

1823 1.5. Microbial Infections

1824 The risk of microbial infection is widely known to be exacerbated by mechanical trauma or physical burns,
1825 but radiation exposure can also greatly increase susceptibility to microbial infection. Patients who develop
1826 the hematopoietic subsyndrome of ARS will have severely weakened immune systems and may also
1827 develop microbial infections independent of any other injuries. (Injury to the GI tract at doses below the GI
1828 syndrome can weaken barriers allowing intestinal organisms to enter the circulation.) To combat these
1829 infections planners should expect the medical response to need large quantities of antimicrobials. Various
1830 antimicrobials are available as part of standard hospital and pharmacy supplies, and some are stocked in

1831 the SNS. Planners should coordinate with local medical professionals to create a plan to acquire and
1832 distribute antimicrobials from the SNS.



Action Item

1833

1834 Ensure that response plans include approaches to receive antibiotics from the SNS, distribute them
1835 to points of care. Local arrangements among healthcare facilities can be an immediate source of
1836 resources (referred to as User Managed Inventories- UMI).



Coordination Opportunity

1837

1838 Planners should coordinate with medical professionals to determine which antimicrobial resources
1839 are available with plans for regional cooperation given that much of the infrastructure outside the
1840 damage zones will be intact. Regional coordination will extend to the wide range of medical supplies.
1841 Experience from COVID-19 is relevant to planning for large-scale catastrophic incidents.

1842 1.6. Psychosocial and Behavioral Healthcare

1843 Following a nuclear detonation, psychosocial and behavioral health impacts will be widely prevalent. Issues
1844 include anxiety, post-traumatic stress disorder (PTSD), fear, depression, psychological distress, and suicidal
1845 ideation. Typically, after large-scale disasters, many of the initial signs and symptoms of mental and
1846 psychological distress resolve between a few days and several weeks but lingering health effects can last
1847 for years or decades following a disaster. A nuclear detonation will be a stressor on the mental and
1848 behavioral wellbeing of the affected population, community, and nation for months or more, delaying
1849 symptom improvement and resolution (Dodgen & Norwood, 2011). Evacuation or relocation, for example,
1850 may worsen symptoms or cause additional health issues. Psychosocial and behavioral health issues may
1851 not be limited to people directly affected by the disaster and include people who observed the detonation,
1852 lost family members, or were otherwise affected.

1853 Planners must coordinate with behavioral healthcare providers, and determine what resources are
1854 necessary and how they can be distributed effectively. Additionally, planners should work with behavioral
1855 healthcare providers to determine how responders can be trained to administer behavioral health first aid,
1856 addressing both responder distress and how to interact with distressed individuals.



Coordination Opportunity

1857

1858 Planners and emergency managers must coordinate with Behavioral Health Community Partners
1859 (BHCPs) to mitigate and prepare for situationally appropriate behavioral stress, psychiatric disorder
1860 development and exacerbation of existing conditions that might worsen in the resource-stress
1861 environment.

1862 2. Initial Mass Casualty Triage in Scarce Resource 1863 Environments

1864 The goal of any triage system is to save as many lives as possible by optimizing use of available resources.
1865 During normal operations, triage systems prioritize the most severe and time-sensitive injuries. When
1866 resources become scarce, however, changing standard medical practices and protocols for triage and
1867 treatment becomes necessary.

1868 2.1. Resource Scarcity

1869 Plans for mass medical care during resource scarcity should be understood across all levels of the medical
1870 system, particularly how and what changes would be authorized.

1871 Prevailing medical standards of care and triage systems will depend on resource availability, which will
1872 change over time. Nomenclature for standards of care varies across jurisdictions, but are usually divided
1873 into three groups: conventional, contingency, and crisis. Nomenclature for resource adequacy also varies
1874 but are usually divided into normal, good, fair, and poor. Medical facilities closest to the damage zones are
1875 likely to have poor resource adequacy. Planners can support these facilities by helping develop appropriate
1876 triage and standards for radiation and combined injuries and ensuring these are shared with responder
1877 organizations.

1878 Devolving into crisis standards of care with some potentially treatable patients relegated to comfort care
1879 can produce enormous stress on responders, healthcare workers and the medical system. Planning for this
1880 requires broad community involvement and, to the extent possible, predetermined indicators, triggers, and
1881 strategies.

1882 Refer To

1883 REMM's Standards of Care: <https://remm.hhs.gov/stdsofcare.htm>

1884 Indicators and Triggers for Potential Movement to Crisis Care:
1885 <https://www.chestnet.org/resources/indicators-and-triggers-for-potential-movement-to-crisis-care>

1886 Action Item

- 1887 ▪ Identify a specific triage system in planning documents and disperse to responder organizations.
- 1888 ▪ Consider holding training or exercise sessions that use the selected triage system.
- 1889 ▪ Ensure that your locality has a plan to implement crisis standards of care.

1890 2.2. Triage

1891 As background for how scarce resource environments, radiation injuries, and combined injuries change
1892 normal triage systems, planners should understand the trauma triage systems used routinely in their area
1893 under normal circumstances, when adequate resources (supplies, staff, space) are available to first
1894 responders, first receivers, and hospital systems. Examples of [commonly used trauma triage systems](#)
1895 include Simple Triage and Rapid Treatment (START); JumpSTART (for pediatric patients); Sort, Assess,
1896 Lifesaving Interventions, Treatment/Transport (SALT); and Department of Defense's (DODs) Delayed,
1897 Immediate, Minimal, and Expectant (DIME). These triage methods, however, don't consider radiation injury.

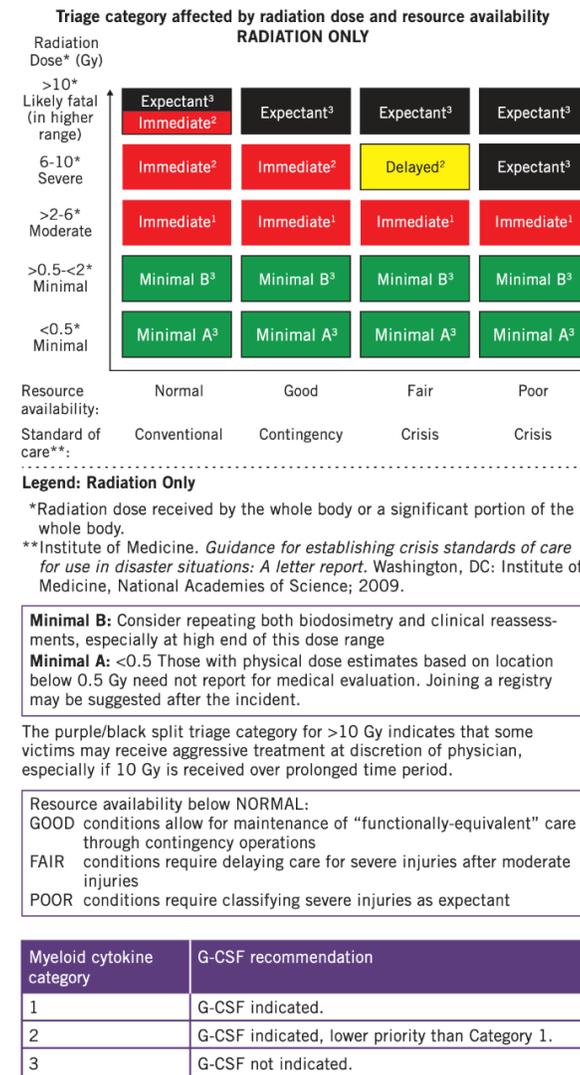
1898 There are [many systems for radiation triage](#), each with a slight variation. The [Exposure and Symptom Triage](#)
1899 [Tool \(EAST\)](#) is an example of a simpler radiation-only triage tool. It is for use in the field *prior to* triage by
1900 medical personnel who will use more sophisticated data-driven triage. Incident leaders and planners
1901 should engage with medical system leaders about which triage systems are most appropriate for their
1902 facilities. These discussions should include questions such as:

- 1903 ▪ What kind of changes to the normal, existing triage systems might need to be made after a nuclear
1904 detonation?
- 1905 ▪ Where exactly changes would be made: at what venues in the field and in hospitals? What
1906 departments within hospitals?
- 1907 ▪ Who is authorized to make these changes?
- 1908 ▪ What exact triggers would be needed to make these changes?
- 1909 ▪ When would standards of care revert and who would make these decisions?

1910 Triage cards are described in depth in the Appendix 4.4: Triage. While planners are not expected to perform
1911 triage themselves, radiation triage cards exemplify how response varies in a scarce resource environment,
1912 which is critical for planners as they allocate resources. As seen in the triage card below for radiation only,
1913 patients with radiation doses less than 6 Gy can be triaged as immediate or minimal regardless of resource
1914 scarcity. However, for doses above 6 Gy, some patients might be triaged as expectant in a scarce (poor)
1915 resource environment who would've been triaged as immediate if more resources are available. This
1916 change in triage demonstrates the importance ensuring healthcare facilities have adequate resources
1917 during the aftermath of a nuclear detonation and makes resource management the most critical role for
1918 planners and emergency managers.

1919 Critical to triage decisions is re-triage as the resource setting changes. A person triaged as expectant might
1920 change to immediate with the influx of resources and personnel.

Triage card 1: RADIATION ONLY—triage category affected by radiation dose and resource availability



1921

1922

Figure 28: Triage Card 1

1923 **2.3. Medical Countermeasures (MCMs) in the Strategic National Stockpile (SNS)**

1924 To address resource scarcity in national emergencies, planners should know how to access supplies
 1925 available via local/regional mutual aid agreements. In addition to local/regional aid, planners should
 1926 anticipate leveraging the [SNS](#)— a federal cache of MCMs and supplies that can be accessed and deployed
 1927 for large public health disasters. The SNS contains resources for treating injuries specific to nuclear
 1928 detonations, such as myeloid cytokines for hematopoietic injury from ARS. Additionally, the SNS contains a
 1929 variety of antimicrobials; burn and blast kits; countermeasures for nausea, vomiting, diarrhea, and pain
 1930 management; supplies to treat mechanical injury; and supplies to treat fluid loss.

1931 Some MCMs in development have received emergency use authorization, including cytokine therapies (G-
1932 CSF). However, they may be in short supply compared to supportive and palliative therapies.

1933 To deploy SNS assets, SLTT officials make requests through their [HHS Regional Emergency Coordinators](#)
1934 [\(RECs\)](#). Some resources can be delivered within 12 hours to pre-selected receipt, storage, and staging
1935 sites.



Refer To

1936

1937 The SNS Website <https://www.phe.gov/about/sns/Pages/default.aspx>



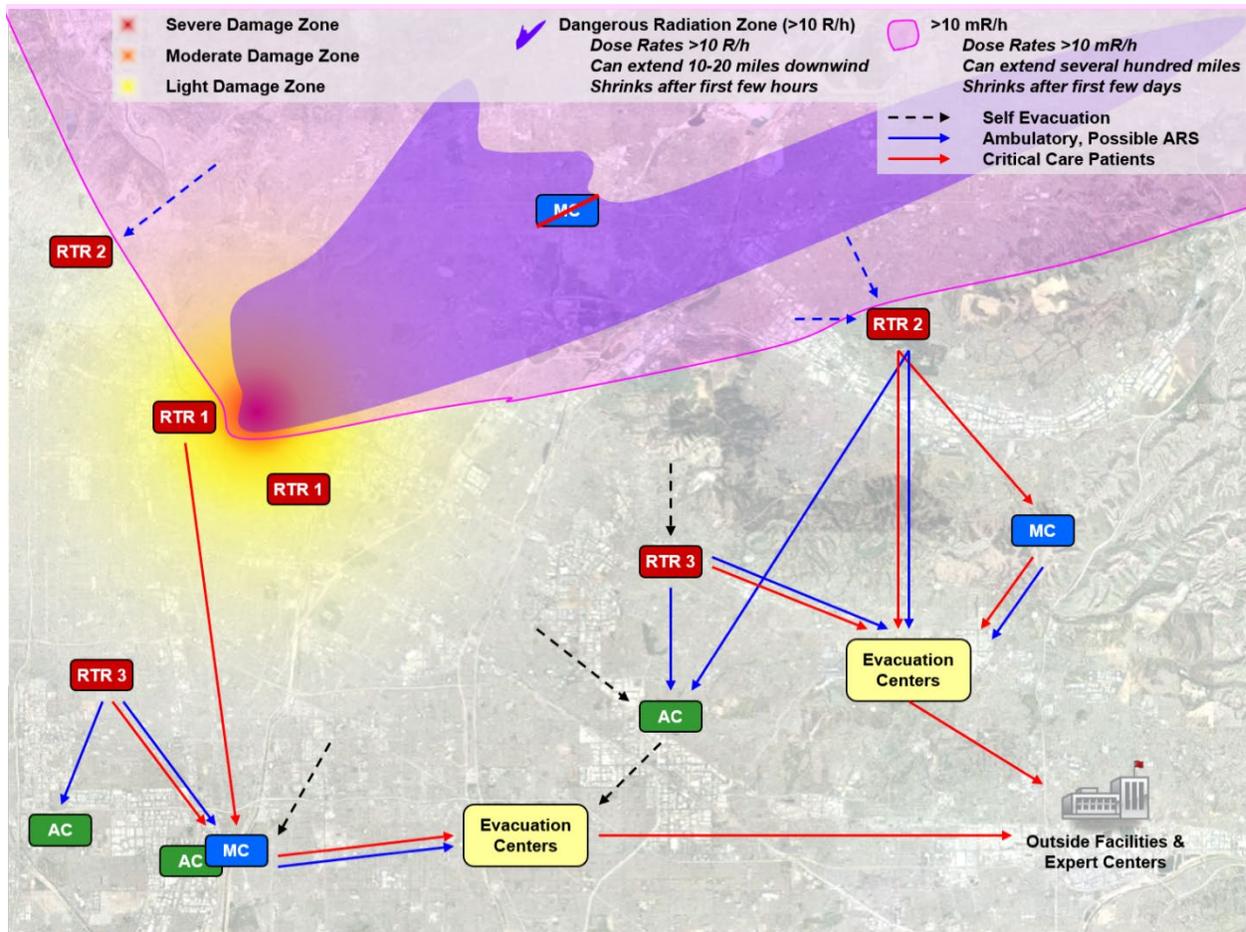
Action Item

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- 1939 ▪ Plans should incorporate assumptions that federal supply delivery will be slowed, due to
1940 infrastructure damage. Assume federal resources will not be available for at least 24 hours.
- 1941 ▪ Develop a plan for countermeasure delivery, storage, and security procedures. This may involve
1942 local, regional, and statewide preplanned systematic approaches.
- 1943 ▪ Develop plans to distribute scarce MCMs, including who is responsible for relevant decisions,
1944 such as where to push SNS resources during response.

1945 3. The Radiation Triage, Treatment and Transport System 1946 (RTR) and Other Medical Response Venues

1947 After a nuclear detonation, patients in need of medical care will be found miles away, in all directions,
1948 from the detonation. Due to the number of casualties and infrastructure damage, typical methods for patient
1949 transportation may be unavailable. To address this challenge, the RTR system was developed by an
1950 interagency medical response-planning group to organize necessary medical care and resources at
1951 strategic locations near the incident. RTR is similar to planning for any emergency incident but specifically
1952 accounts for the presence of ambient radiation with the limits it imposes on time spent in a specific location.
1953 RTR involves both ad hoc self-organizing locations (RTR 1-3) and pre-determined locations (Assembly
1954 Centers, Medical Centers, evacuation and transport centers and expert medical care facilities on a regional
1955 and national level). These are utilized in real-time based on GIS location using systems such as
1956 [GeoHEALTH](#). The RTR systematic approach is intended to characterize injuries while simultaneously
1957 organizing and efficiently deploying appropriate material and personnel assets to stabilize and treat
1958 victims. RTR sites will be operated by a combination of EMTs and volunteers. Volunteers will likely include
1959 HHS Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP) and ad hoc
1960 volunteer health professionals at the time of the incident. If resources (such as point of care dosimetry) are
1961 available, RTR sites may be able to effectively triage radiation injuries, traumatic and thermal burn injuries,
1962 and administer cytokines.



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Figure 29: An example layout of the RTR system and various sites involved, including self-evacuation, ambulatory, and critical care routes and relationships.

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The [RTR System](#) is shown in the diagram above, depicting potential locations and interactions of physical damage zones, radiation fallout zones, and the medical response venues in relation to a notional nuclear detonation site. The RTR system is composed of four types of sites – RTR sites, assembly centers (ACs), medical centers (MCs), and evacuation centers (ECs) – each serving a distinct function. The RTR 1-3 sites will likely form spontaneously during an incident. Planners can select other medical sites in advance. RTR 3 sites may be at designated assembly centers (ACs), depending on location and infrastructure.

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Action Item

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Establish a GIS based approach for use for emergency incidents. This is applicable to emergencies in general. RTR accounts for the presence of radiation.

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1976

Ensure emergency messaging includes directions or instructions for ambulatory victims to transport themselves to ECs or MCs.

1977



Refer To

1978

The “RTR” Medical Response System for Nuclear and Radiological Mass-Casualty Incidents: A

1979

Functional TRIage-TReatment TRansport Medical Response Model:

1980

<https://pubmed.ncbi.nlm.nih.gov/19618351/>

1981

3.1. RTR 1: Located where there is both physical damage and radiation; responder time limited and monitored.

1982

1983

RTR 1 sites are ad hoc triage and initial treatment sites in the MDZs or LDZs, where fallout might overlay physically damaged sites, and serve to stabilize patients and route casualties towards appropriate medical care or other centers. Local Emergency Medical Services (EMS) personnel and volunteers will likely operate RTR 1 sites only after the radiation hazard subsides, setting up the site where they encounter groups of evacuating or self-evacuating populations. To protect responders, radiation monitoring and predetermined exposure limits are essential at RTR 1 sites. RTR 1 site casualties will likely include thermal burns, fractures, lacerations, bleeding, radiation, and combined injuries. Treatment activities include traumatic injury stabilization, initial burn coverage, and trauma and radiation victim triage.

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3.2. RTR 2: Located where there is radiation fallout and limited physical injuries; responder time must be monitored and recorded to minimize exposure.

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1994

The RTR 2 sites are possibly within and on the edge of fallout zones, where people self-congregate. Radiation in the environment will be present and, to ensure responder safety, local radiation levels must be monitored to determine how long responders are permitted to work safely. At these sites, local EMS and volunteers perform initial triage assessments and stabilization, then route people to MCs, ACs, or home to self-decontaminate. With the rapid decline in radiation from fallout, it is important to make decisions based on up-to-date measurements.

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3.3. RTR 3: Located in areas with little to no radiation and/or physical damage.

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RTR 3 sites are outside damage and radiation zones, likely operated by local EMS and volunteers. Expected casualties at RTR 3 sites are limited but may include those with radiation exposure, thermal burns, and mechanical trauma. Since these sites are outside the damage zones, injuries at these sites are expected to be relatively minor but may include self-evacuees with more serious injuries or individuals who were severely injured outside the damage zones (e.g., in car accidents caused by flash blindness). Operators will provide stabilization and radiation triage before routing patients to MCs, ECs, or home. Some RTR3s may become ACs.

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3.4. Medical Centers (MCs)

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MCs triage people, stabilize patients, or provide necessary interventions before discharging or routing patients to outside expert facilities or ECs. MCs will be in the surrounding local area, upwind of initial

2010

2011 fallout plume and will include hospitals, urgent care centers, field hospitals, and other medical or
2012 healthcare facilities nearby. MC staff will likely be healthcare professionals, EMS staff, volunteers, non-
2013 governmental organizations (NGOs), and federal support personnel. The Federal Medical System (FMS) is
2014 designed to set up field hospitals which could serve as MCs – planners should familiarize themselves with
2015 FMS and other NGOs who could provide support if requested. Expected injuries are in all three categories
2016 (trauma, thermal burns, radiation) and will range in severity. Major medical intervention, such as surgery
2017 and transfusion, will be available at these sites. Gross decontamination may be performed, preferably
2018 outside the MC. There may be infrastructure damage near these sites, but transportation to ECs or expert
2019 centers – medical facilities with specific medical expertise, such as burn care centers - may be possible.
2020 Myeloid cytokines may be administered at MCs.

2021 **3.5. Assembly Centers (ACs)**

2022 Most ACs will be at predetermined sites, but some will form spontaneously. ACs perform ad hoc screening
2023 and gross decontamination (as discussed in Chapter 5) as well as basic medical care, stabilization, and
2024 triage. CRCs and ACs are equipped to perform technical assessments of radiation dose exposure. See
2025 Chapter 5 for more CRC information. ACs will contain people displaced by infrastructure loss. In addition to
2026 local EMS and volunteers, NGOs may be AC operators. If resources are available, myeloid cytokines may be
2027 administered at ACs.

2028 **3.6. Evacuation Centers (ECs)**

2029 As patients are screened, triaged, decontaminated, and stabilized, they will be transitioned to ECs, where
2030 they will be transported to complete care sites, expert radiation centers, or CRC mass care shelters further
2031 from the affected areas. All types of injuries can be expected here. Decontamination before transport may
2032 be necessary. Myeloid cytokines may be administered, or re-administered, depending on patient arrival and
2033 wait times.

2034 **3.7. Expert Centers**

2035 After initial radiation screening and stabilization at RTR sites and MCs, patients with severe thermal or
2036 radiation burns or who are at risk for severe ARS will transition to expert centers. Burn casualties require
2037 specialized expert care and may be transferred to [specialized burn centers](#), though the total number of
2038 burn beds nationwide is extremely limited. For radiation injury expertise, clinicians should consult the RITN.
2039 Many RITN centers are also equipped to handle burn and major trauma injuries. Trauma centers will also
2040 care for victims. As the hematopoietic subsyndrome of ARS can develop days to weeks after initial
2041 exposure, some patients may be managed as outpatients until they develop severe illness. Telemedicine
2042 may be necessary to leverage both burn and ARS expertise as well as other specialized assets for the large
2043 surge in patients.

2044 Coordination Opportunity

- 2045 ▪ Local and regional planners should coordinate with RITN facilities when developing nuclear
2046 detonation response plans.

- 2047
2048
- Coordinate with the American Burn Association to identify burn centers and best practices regarding mass casualty burn incidents.



Refer To

2049
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2051
2052

The **RITN**, is a consortium of U.S. medical specialists with expertise and plans for implementing care during major emergencies. Telemedicine consultation with RITN may also be implemented during emergencies with large numbers of patients. <https://ritn.net/treatment/>

2053
2054

The **American Burn Association** is also an expert referral center for burn patients. Telemedicine consults may be available. <http://ameriburn.org/public-resources/find-a-burn-center/>

2055 4. Fatality Management

2056 Following a nuclear detonation, the large number of fatalities will overwhelm medical examiners/coroners
2057 (ME/Cs). Many victims may never be found or identified. A respectful, culturally sensitive plan for fatality
2058 management will directly impact public perception of the government's emergency management abilities
2059 and the community's ability to recover. This document focuses on early response, when lifesaving
2060 operations will take precedence over fatality management, but with time, fatality management will have
2061 increasing importance.

2062 After a nuclear detonation, need for fatality management will likely exceed anything experienced in past
2063 disasters. Fatality management includes recovery, identification, storage, final disposition, notification of
2064 next-of-kin, and death certificates.



Coordination Opportunity

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Coordinate with communications experts to consider creating a dedicated phone line or website specifically for collecting fatality information.

2068 4.1. Handling Contaminated Remains

2069 In the immediate aftermath of a nuclear detonation, a small minority of the fatalities handled by ME/Cs will
2070 be contaminated. Most of these fatalities will be victims who evacuated and died because of traumatic or
2071 thermal injuries. As a result, many of them will have been decontaminated during evacuation or medical
2072 treatment. As the response unfolds and remains are recovered from the damage zones, the probability that
2073 remains are contaminated increases. Complete external decontamination may not be possible for all
2074 decedents, and internal decontamination is not necessary or possible. Decontamination should follow any

2075 victim identification, forensic, or medicolegal³¹ work. Planners should coordinate with radiation experts to
2076 understand the risks of handling contaminated remains and develop effective protective measures for
2077 responders.



Coordination Opportunity

2078
2079 Coordinate with radiation experts and health physicists to understand the risks of handling
2080 contaminated remains and develop plans to protect responders and ME/Cs.

2081 From a planning perspective, handling contaminated remains is very similar to screening and
2082 decontaminating living people. Responders and ME/Cs responsible for receiving and processing decedents
2083 should have access to radiation detectors to survey remains; appropriate dosimetry; and either soap and
2084 water, or an appropriate dry decontamination method (e.g., vacuums with HEPA filters). Radiation
2085 contamination control methods should be included in plans to prevent the spread of radiation and reduce
2086 dose to ME/Cs working to process fatalities. Generally, following decontamination, no special container or
2087 transport method will be required for contaminated remains. If remains still exceed contamination limits
2088 following decontamination, temporary internment or storage at the site may be necessary.

2089 The final resting place for contaminated remains should be considered carefully during planning. Lead
2090 coffins are generally not recommended as they pose an additional environmental hazard due to leeching
2091 heavy metals. Cement coffins are a better alternative, serving the same purpose without the environmental
2092 risks. Similarly, cremation is not generally recommended due to the potential concentration of remaining
2093 radionuclides and the potential for contamination of the cremation facility.

2094 As with all fatality management, care should be taken in planning to ensure respect for the remains is
2095 maintained throughout the process. Handling of contaminated remains still requires planners to
2096 accommodate the social, cultural, and religious considerations of the deceased and their families to the
2097 maximum extent possible.



Refer To

2098
2099 *CDC Guidelines for Handling Decedents Contaminated with Radioactive Materials*
2100 <https://www.cdc.gov/nceh/radiation/emergencies/pdf/radiation-decedent-guidelines.pdf>

³¹ Of or relating to both medicine and law.

2101



Action Item

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Develop effective protective measures for emergency workers handling contaminated remains, such as ME/Cs.

2104 4.2. Fatality Management Resource Sharing

2105 SLTT entities have limited fatality management capabilities and will quickly exhaust their resources,
2106 requiring additional assistance. Even federal mortuary capabilities are limited. It may be necessary to lower
2107 public expectations and use nontraditional disposition techniques (e.g., temporary interment).

2108 Additionally, planners should work with neighboring states and jurisdictions to facilitate fatality
2109 management resource sharing. In particular, interstate coordination must be planned in advance, because
2110 state legislation may impede fatality transportation and other mortuary services across state lines.

2111



Coordination Opportunity

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2113

Coordinate with surrounding states to address legal constraints of fatality management, movement, and tracking.

2114 4.3. Fatality Management Planning Considerations

2115 Before developing fatality management guidance, planners must develop a thorough understanding of
2116 their community's relevant cultural practices, so they can respectfully integrate them into plans. With that
2117 in mind, to prepare for fatality management following a nuclear detonation, SLTT planners should:

- 2118 1. Designate a proper medical/legal authority to lead the fatality management operations.
- 2119 2. Identify available fatality management capabilities in their jurisdiction (e.g., personnel, equipment,
2120 supplies).
- 2121 3. Create a comprehensive, incident-specific plan for managing contaminated decedents, including
2122 procedures for gathering, recovering, transporting, storing, and disposing of remains.
- 2123 4. Develop a comprehensive health and safety plan to protect those handling decedents, including
2124 personal monitoring devices (described in Chapter 2).
- 2125 5. Develop guidelines for conducting notification or disposition meetings with next-of-kin and keeping
2126 next-of-kin apprised of identification activities.
- 2127 6. Develop guidelines for gathering fatality information data, such as collecting family reference DNA.
- 2128 7. Consider potential cross-contamination hazards when developing fatality management plans.
- 2129 8. Anticipate requesting mortuary assistance from outside the impacted area.

2130 9. Create public messages regarding how decedents will be handled and develop a plan for handling
2131 public concerns or requests.

2132 There are many references and resources available to support planners with fatality management—to
2133 access these resources, visit Appendix 4.7: Resources for Medical Examiners and Coroners (ME/Cs) and
2134 Fatality Management Planning and Appendix 4.6: Response Support Teams and Planning Resources.

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Chapter 5: Contamination Screening, Decontamination, and Long-term Follow-up

2139 The recommendations in this chapter are derived from HHS CDC publication *Population Monitoring in*
2140 *Radiation Emergencies: A Guide for State and Local Public Health Planners* and *A Guide to Operating*
2141 *Public Shelters in a Radiation Emergency*.

2142



Refer To

- 2143 ▪ *Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health*
2144 *Planners*: [https://www.cdc.gov/nceh/radiation/emergencies/pdf/population-monitoring-](https://www.cdc.gov/nceh/radiation/emergencies/pdf/population-monitoring-guide.pdf)
2145 [guide.pdf](https://www.cdc.gov/nceh/radiation/emergencies/pdf/population-monitoring-guide.pdf)
- 2146 ▪ *A Guide to Operating Public Shelters in a Radiation Emergency*:
2147 <https://www.cdc.gov/nceh/radiation/emergencies/pdf/operating-public-shelters.pdf>)

2148 Population monitoring describes the process of identifying, screening, and monitoring people for exposure
2149 to radiation or contamination with radioactive materials. Decontamination is the process of washing or
2150 removing radioactive materials on the outside of the body or clothing (external) and, if necessary,
2151 facilitating removal of contamination from inside the body (internal).

2152 Figure 30 displays possible ad hoc, CRC, and mass care shelter locations relative to the incident site. Many
2153 of the activities at these three locations will be similar.



2154

2155

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Figure 30: Example of ad hoc, CRCs, and mass care shelter screening locations relative to the incident site. Site roles and movement from one site to another are described throughout Chapter 5.

2158

Contamination screening can be categorized based on the location where screening occurs:

2159

Ad hoc location: Occurs near the incident site as people leave the affected area. The purpose of ad hoc screening is to quickly identify highly contaminated individuals that need to be decontaminated promptly, to avoid accruing a large dose. Ad hoc screening will be performed once local authorities determine it is safe for people to start evacuating the area. Ad hoc contamination screening may take place at or near stand-alone locations or collocated with ACs, ECs, RTRs, or other locations set for that purpose. Ad hoc screening does not replace the more detailed/deliberate screening at CRCs.

2164

2165

CRCs: CRCs are designed to screen, decontaminate, and register people, and will be located outside the impacted area. CRCs also address the needs of displaced populations and concerned citizens hundreds of miles from the blast, whose needs differ from those of the victims near the detonation. CRCs can also identify individuals subjected to higher exposure and refer them to appropriate medical care or follow-up.

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2168

2169 Regardless of location or proximity to the impacted area, when the term population monitoring is used in
2170 this guide it is assumed to be describing an activity taking place at a CRC or mass care shelter.

2171 **Mass care shelter screening:** Mass care shelter screening occurs at mass care shelters set up outside the
2172 impacted area that are close to CRCs. Ideally, individuals will arrive at mass care shelters after
2173 decontamination/screening at an ad hoc location or CRC. However, mass care shelters may receive
2174 individuals who have not been decontaminated/screened.

2175 The *CDC Population Monitoring Guide* does not explicitly use a graded system for staffing and resourcing at
2176 CRCs. A subsequent CDC guidance document, *The Shelter Guide* describes a graded system for mass care
2177 shelters based on the availability of radiation detection resources. This graded approach can be extended
2178 to ad hoc and CRC locations.

2179 The graded contamination screening approach includes three capability categories based on complexity or
2180 radiation detection capability:

- 2181 ▪ **Basic capabilities:** The minimum capabilities necessary to operate a facility following a radiation
2182 incident. Many of the recommendations provided in this chapter are precautionary and address
2183 facilities that lack access to radiation detection equipment and trained personnel.
- 2184 ▪ **Intermediate capabilities:** Enhanced radiation detection capabilities and access to trained staff.
2185 However, these resources may be in limited supply, and facility operators may need to prioritize these
2186 resources.
- 2187 ▪ **Advanced capabilities:** Sufficient access to radiation detection equipment and trained staff to perform
2188 all tasks requiring the application of these resources.

2189  Refer To

2190 *The Shelter Guide:* [https://www.cdc.gov/nceh/radiation/emergencies/pdf/operating-public-](https://www.cdc.gov/nceh/radiation/emergencies/pdf/operating-public-shelters.pdf)
2191 [shelters.pdf](https://www.cdc.gov/nceh/radiation/emergencies/pdf/operating-public-shelters.pdf)

2192  What Would You Do?

2193 How would you categorize your contamination screening (radiation detection) capabilities?

2194 This chapter walks through these considerations and discusses the process of screening and
2195 decontaminating all affected populations. Additionally, this chapter includes a discussion of how these
2196 processes are applied at CRCs and mass care shelters. Appendix 5.5 includes an expanded discussion of
2197 available tools and resources as well as several additional factors for consideration during planning.

2198 1. Primary Considerations for Screening

2199 There are several primary considerations for screening. These are particularly critical for nuclear
2200 emergencies because of the high number of casualties. **The immediate priority of any contamination**
2201 **screening is to identify individuals whose health is in immediate danger and require urgent care.** Near the
2202 incident scene, contamination screening can be accomplished as part of medical triage described in Chapter
2203 4, or at ad hoc settings. **Regardless of location, management of serious injury takes precedence over**
2204 **radiological decontamination.**

2205 Contamination screening activities and decontamination services offered should remain flexible and
2206 scalable to reflect the prioritized needs of individuals and availability of resources at any given time
2207 and location.



2208 Action Item

2209 Develop scalable and flexible contamination screening and decontamination plans and policies.

2210 Following a nuclear detonation, the primary considerations for screening are:

- 2211 1. **The primary purpose of contamination screening is detection and removal of external contamination.**
- 2212 2. **Screening and a few key questions (regarding location and exposure time) can be used to identify**
2213 **people with potentially high exposure, who are likely to develop ARS.**
- 2214 3. **In most cases, external decontamination can be self-performed if straightforward instructions are**
2215 **provided.** Promoting self-decontamination can reduce the CRC and mass care shelter workload,
2216 because screening self-decontaminated individuals can be expedited.
- 2217 4. **The primary concern when monitoring for radioactive contamination is acute radiation health effects.**
- 2218 5. **Contamination screening personnel should offer or recommend gross external decontamination,** such
2219 **as brushing away dust or removal of outer clothing. Gross decontamination should generally be**
2220 **sufficient to prevent acute radiation health effects to the skin or whole body. Cross-contamination³²**
2221 **issues are a secondary concern, especially in a nuclear emergency.**
- 2222 6. **Contamination screening and decontamination activities should remain flexible and scalable to reflect**
2223 **available resources and competing priorities.** For example, screening criteria at an ad hoc location may
2224 be less stringent than at a CRC or mass care shelter, because its primary purpose is to identify the
2225 most contaminated individuals and prioritize their decontamination. In those situations, quick
2226 decontamination may involve removal or careful brushing of external clothing, followed by the use of

³² Cross-contamination, in this context, refers to contaminated individuals exposing others to contamination by contaminating surfaces or coming into contact with others.

2227 wet wipes or dry decontamination methods for exposed skin. When water is scarce or needed to fight
2228 fires, wet wipes, or dry methods³³ can be used for decontamination.

2229 7. **Radioactive contamination is not immediately life threatening.** Decontamination doesn't take the same
2230 priority as other life-threatening hazards or injuries. Since decontamination involves removal of
2231 contaminated clothing and washing of exposed body surfaces, it does not require special expertise,
2232 individuals who are self-evacuating may be advised to self-decontaminate. Suggestions for monitoring
2233 and decontamination in this chapter assume radioactive material is the only contaminant and that
2234 there are no chemical or contagious biological agents present.



What Would You Do?

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2236 How do you think your constituents would self-decontaminate if they were not given specific
2237 guidance?

2238 Contamination screening can be very resource intensive and requires subject-matter expertise to
2239 accomplish effectively. For details about available screening support resources, see Appendix 5.2:
2240 Strategies for Screening and Decontaminating People.

2241 2. The Contamination Screening Process

2242 Contamination screening begins soon after a nuclear/radiological incident and continues until all
2243 potentially affected people have been monitored and evaluated for the following:

- 2244 1. Necessary referral for medical treatment
- 2245 2. Presence of radioactive contamination on the body or clothing (external contamination)
- 2246 3. Intake of radioactive materials (internal contamination)
- 2247 4. Removal of external or internal contamination (decontamination)
- 2248 5. Radiation **dose** received and resulting health risks
- 2249 6. Assessment of long-term health effects

2250 The first five elements listed above should be accomplished as soon as practical, though some facilities may only
2251 be able to carry out the first two. These first two are the most critical and can take place at an ad hoc, CRC, or
2252 mass care shelter location.

2253 Elements three and four will likely occur at CRCs or mass care shelters with radiation detection capabilities.
2254 Although assessment of internal contamination (i.e., quantification of intake rather than presence of internal

³³ Dry decontamination, such as wet wipes, methods do not utilize water, so they are ideal for cold weather or scarce water situations.

2255 contamination) would not occur at a CRC or mass care shelter, these facilities may identify people with
 2256 potential for internal contamination. If equipped, CRCs and mass care shelters may collect urine samples to
 2257 assess likelihood of internal contamination.

2258 Elements five and six will be determined jointly by public health and radiation control staff, likely located
 2259 outside of the aforementioned facilities. The results would be communicated to the individuals through their
 2260 health departments. Long-term health effects will be assessed with a population registry and epidemiologic
 2261 investigation that will likely span several decades. Those activities are beyond the scope of this guidance.

2262 Table 6 summarizes which activities will likely occur at the aforementioned locations.

2263 **Table 6: Range of Anticipated Capabilities for Screening, Decontamination and Dose Assessment by**
 2264 **Location**

| Location | Ad-hoc RTR System | CRC | Mass Care Shelter | Offsite |
|---|--|------|-------------------|---------|
| Referral for Immediate Medical Need | X | X | X | |
| External Contamination Screening | X | X | X | |
| Initial Assessment for Internal Contamination | | X** | X** | X* |
| External Decontamination | X (gross decontamination may be done here) | X | X | |
| Dose Assessment | | X*** | X*** | X* |
| Risk Assessment for Long-Term Health Effects | | | | X* |

2265 Notes:

2266 * Conducted by Radiation Control Program, local health department, or both (not tied to specific location).

2267 ** Only for triaging and urine collection when internal contamination is suspected.

2268 *** Not likely in most settings, but some locations may be able to do early estimates of doses based on external
 2269 exposure when location at time of incident and duration of exposure are known.

2270

2271 Early radioactivity monitoring and decontamination decisions must be made in the context of overall
 2272 response operations.

2273 For example, stringent contamination screening criteria at ad hoc locations may delay prompt evacuation.
 2274 Therefore, radiation survey methods, radiation screening criteria, decontamination guidance, and other
 2275 services should be adjusted to prioritize individuals' needs and resource availability.

2276



Action Item

2277

Ensure plans address a range of available resources and priorities.

2278

2.1. External Contamination Screening

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The first step of external contamination screening is to check for radioactive contamination on individual's bodies and clothing. Detailed radiological surveys are not necessary, so initial screenings for external contamination can be done in a matter of seconds by trained professionals using proper radiation detection instruments. Depending on the situation, available staff, and available decontamination resources, more restrictive radiological screening criteria may be used.

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External contamination screening may be a very quick process at ad hoc screening locations. The primary goals are to identify the most contaminated individuals and provide self-decontamination instructions. External contamination screening at CRCs may be more deliberate and detailed, depending on available resources and the number of affected individuals. At CRCs, this may range from only screening using a portal monitor to using a portal monitor followed by screening with handheld instrumentation, to pinpoint contaminated areas. Screening at a mass care shelter may also be more deliberate and detailed, depending on available resources.

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There is no universally accepted level of radioactivity (external or internal) above which a person is considered contaminated and below which a person is considered uncontaminated. A discussion of key considerations in selecting a contamination screening criterion and a number of benchmark screening criteria are provided and referenced in Appendix D of the CDC [Population Monitoring in Radiation Emergencies](#) guide. Key considerations include instrumentation available (type, number); throughput³⁴; next destination (where people are being sent after screening); time since detonation, to account for changes in isotope mix; etc.

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Screening levels may be adjusted when large populations require screening in a short time period, especially when resources are limited. Subsequently, state and local planners should consider a range of circumstances and establish operational levels for several circumstances beforehand. Pre-established values can be communicated clearly to emergency response authorities early in response. It is important to note that different values are used for different purposes and users are encouraged to pre-determine screening values based on their resources, and revise as conditions improve. Ad hoc locations should focus on high throughput screening to minimize fallout exposure, especially in the first few hours and days following an incident. The rapid decay of fallout radiation in the first few hours and days of the

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³⁴The total number of people that can be processed by unit time (hourly, shift, etc.).

2306 incident mean that a delay in screening/decontamination could result in significant additional dose by
 2307 victims.

2308 Screening level guidance for CRCs and mass care shelters is available on [RadResponder's resource](#)
 2309 [page](#), though an account is required for access.



What Would You Do?

- 2311 ▪ How would your screening criteria change farther from the incident?
- 2312 ▪ What resources (expertise, instrumentation, etc.) do you currently have for screening? How might
 2313 your operational levels vary if you had more resources? What about fewer resources?

2314 **Table 7: Summary of Key Guidance Documents Recommended "Target Levels for Decontamination" of**
 2315 **People (derived from Samuels C, 2019) ***

| Documentation | β/γ Screening Criteria | Contamination Radionuclide | Skin-to-Detector Separation | Contamination Extent | Exposure Time |
|--|---|----------------------------|-----------------------------|--|---|
| Background information on FEMA-REP-22‡ | 1,000 counts per minute ³⁵ (cpm) <i>fixed</i> / 10,000 cpm <i>loose</i> above background radiation ³⁶ (bkg) | Cs-137/Ba-137m | 2.54 cm | 0.2 cm ² spot with widespread | 14 days <i>fixed</i> /36 hours <i>loose</i> |
| Conference of Radiation Control Program Directors (CRCPD) Handbook | 10,000 cpm above bkg | Cs-137/Ba-137m | 2.54 cm | Widespread | Not specified |
| EPA 2017 PAG Manual | 2x bkg | Not specified | Not specified | Not specified | 12 hours |

³⁵ Counts per minute (cpm) refers to the amount of incident radiation counted by a detector. This value is smaller than dpm (see footnote 8) since detectors only count radiation that hits the detector, missing any that goes off in any other direction.

³⁶ Background radiation is the combined natural radiation in the environment from naturally radioactive materials on earth and cosmic radiation from space. The amount of background radiation varies by location, depending on local geography, altitude, and other features. Background radiation will be higher during emergency and responders should use the elevated background present at their screening location.

| Documentation | β/γ Screening Criteria | Contamination Radionuclide | Skin-to-Detector Separation | Contamination Extent | Exposure Time |
|--|--|-----------------------------------|-----------------------------|--|-----------------------------|
| International Atomic Energy Agency (IAEA) Operational Interventional Levels (OILs) for Reactor Emergencies | β: 1,000 counts per second (cps) γ: 1 Sv/h (100 rem/hr) | Light Water Reactor emergency mix | β 2 cm γ: 10 cm | Not specified | Not specified |
| NCRP Report No. 161 | 10,000 Bq/cm ² †† (1,000 Bq/cm ²) † | Sr-90 | 1 cm | 0.2 cm ² spot with widespread | Not specified |
| NCRP Report No. 165 | 600,000 disintegration per minute ³⁷ (dpm)/cm ² | Sr-90 | 1 cm | Not specified | Not specified (>6-12 hours) |
| NCRP Report No. 166 | 1,000 cpm | Sr-90 | 1 cm | Not specified | 24 hours |

2316 * Various U.S. and international agencies have recommended "target levels for radiation decontamination" of people
 2317 during incidents of various kinds, sizes, and venues.

2318 ‡ Based on CD V-700 retrofitted with a pancake GM. The modern GM values are 10,000 for fixed and 100,000 for
 2319 loose contamination

2320 † Intervention is advisable

2321 †† Intervention is required

2322

2323 As uncontaminated people at the CRCs are referred to discharge stations and contaminated people are
 2324 referred to washing (decontamination) stations, contaminated and uncontaminated people should not
 2325 comingle, though families should not separate. Wrist bands or similar tools can be used to distinguish
 2326 people who have been screened and cleared through decontamination.

2327 Most people will be able to self-decontaminate at home or at other locations, prior to arriving at the CRCs,
 2328 but there must be provisions for those who cannot, such as those who cannot access showers or sinks.

2329 During the decontamination process, a best practice is to determine if parents can assist their children
 2330 with washing. Direct those who do not have wounds to self-decontaminate as described in Section 3.3.

³⁷ Disintegrations per minute (dpm) refers to the number of atoms that decay in one minute given a particular amount of radioactive material.

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Action Item

2332

Include a method for distinguishing screened individuals from unscreened individuals.

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What Would You Do?

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How might decontamination provisions vary for people with disabilities, functional needs, or access needs?

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Use of pumper fire truck systems for mass decontamination, although effective for decontaminating large numbers, is discouraged and may be unadvisable when other decontamination methods are available. If

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water resources are scarce or not available, changing of outer clothing or carefully brushing off fallout dust can significantly reduce exposure. When there are cold temperatures or poor weather conditions, water-based decontamination techniques may be unadvised, so local decontamination of exposed skin using sink, wet wipes, etc. may be preferred. Furthermore, firefighting resources may be more urgently needed to fight fires or conduct search and rescue operations.

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What Would You Do?

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How would you implement decontamination when water resources are scarce?

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To the extent possible, emergency workers should attempt to contain the spread of contamination from runoff or solid waste generated by decontamination activities. However, containment measures should not slow or delay evacuating contaminated individuals. Addressing peoples' needs and facilitating their decontamination or evacuation takes priority.

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People in need of medical care must be directed to a medical treatment facility or a designated medical triage station, if established. Response organizations should be prepared to provide security for designated monitoring, decontamination, and staging areas.

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2352 2.2. Internal Contamination Screening

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Internal contamination is radioactive material that has entered the body via ingestion, inhalation, or a wound. Following a nuclear detonation, internal contamination is a minor health concern relative to burn injuries, traumatic injuries, or high external radiation doses from initial radiation exposure or nuclear fallout. However, there is potential for internal contamination and, regardless of relative significance, internal contamination can be a source of anxiety for the public. MCMs for internal contamination only treat a few radionuclides, not all the radionuclides present following a nuclear detonation.

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Action Item

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Ensure plans prioritize life threatening or other severe injuries over contamination screening and decontamination.

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2362 While not an immediate priority following a nuclear detonation, accurate information about levels of
2363 internal contamination is critical for determining when medical intervention is necessary. For some
2364 radionuclides, external contamination screening can indicate the extent of internal contamination. Physical
2365 location during the incident and external contamination can also indicate the likelihood and degree of
2366 internal contamination. Individuals with high levels of contamination above their shoulders are more likely
2367 to be internally contaminated, due to inhalation or ingestion of contaminated material. First responders,
2368 pregnant individuals, and children should be prioritized for internal contamination screening.

2369 The methods and equipment for assessing internal contamination are more advanced than those required
2370 to conduct external monitoring. Specifically, internal contamination screening requires laboratory urine
2371 analysis and health physics support to interpret results. Collectively, internal contamination monitoring
2372 procedures are referred to as 'bioassays'. Generally, these bioassays require off-site analysis of urine
2373 samples by a clinically certified government or commercial laboratory. Although some results will be
2374 available quickly, it may be weeks or months before all results are available, depending on the size of the
2375 population monitored and the radionuclides involved. Laboratory results can provide definitive
2376 contamination information, especially in the case of alpha-emitting radionuclides.

2377 State and local authorities must work with ESF-6 (Mass Care, Emergency Assistance, Housing, and Human
2378 Services) and the American Red Cross to establish an evacuee tracking system. This system can promptly
2379 locate evacuees, patients, fatalities, survivors, displaced persons, and other victims. Extensive hurricane
2380 response experience and tools can be used to achieve this.

2381 State and local agencies should establish a survivor registry and locator databases as early as
2382 possible. Initially, the most basic and critical information to collect from each person is his or her
2383 name, address, and contact information.

2384 2.3. Self-Decontamination

2385 For most people, steps to removing or reducing external contamination in the initial hours, perhaps days, will
2386 be self-performed. Family members, companions, or caregivers can assist individuals as necessary. Emergency
2387 management officials must quickly provide simple and straight forward instructions in languages appropriate
2388 for the affected community. As discussed in Chapter 6, communication after a nuclear detonation will be
2389 difficult due to loss of infrastructure. Every possible communication outlet should be used to provide life-
2390 saving messages, including instructions for self-decontamination.

2391 For most people, a thorough wash or complete removal of external contamination will not be practical in
2392 the early hours or days, but any action to reduce the external contamination should be encouraged. It is

2393 important to emphasize the importance of ‘dusting off’³⁸ as often as possible, until people can change
2394 clothes or wash. In providing instructions for self-decontamination, the use of phrases such as ‘washing’
2395 and ‘change of clothes’ are preferred to ‘decontamination’, because they are easier to understand,
2396 provide the same meaning more clearly, and sound less threatening.



Action Item

2397

2398 Ensure decontamination messaging is clear and concise, avoiding jargon.

2399 Another challenge in providing blanket self-decontamination instructions is that peoples’ circumstances,
2400 supplies, and facilities may vary greatly. For example, some may not have access to water, clean
2401 replacement clothing, or bags to store away contaminated clothing. Examples of instructions include:

- 2402 ▪ If you must be outdoors when fallout is accumulating, do not remove your clothing. Gently dust off
2403 any visible fallout dust while being careful not to breathe or swallow the dust. If possible, do not use
2404 your bare hands to dust off your clothes, but try to use a brush, paper towel, etc. that will not put your
2405 hands in direct contact with the clothing.
- 2406 ▪ Once you have some overhead cover or no visible fallout is accumulating, if you have an outer layer of
2407 clothing (coat or jacket), remove it, place it inside a bag if available, tie securely, and store it away from
2408 people. Instructions for appropriate disposal of contaminated clothing should be provided by
2409 authorities as applicable.
- 2410 ▪ If you are not wearing an outer layer and have only a single layer of clothing, keep dusting it off until
2411 you have access to clean clothing.
- 2412 ▪ If the weather is severely cold and you need to keep your outer layer, keep dusting it off until you have
2413 access to clean replacement clothing or are no longer exposed to cold temperatures.
- 2414 ▪ When you arrive at home or another destination, act as if you are covered with mud and try to
2415 minimize tracking the material inside. Remove shoes and, if possible, change clothes and place the
2416 contaminated clothing in a bag. Place the bag as far away as possible from people and animals until
2417 you receive further instructions from officials.
- 2418 ▪ At the earliest possible time, shower with warm water and soap. Use shampoo if available, but do not
2419 use hair conditioner. If no shower is available, use a sink and wash as best you can, paying particular
2420 attention to your hair and areas around your mouth, nostrils, and eyes. If no water is available, use
2421 wet wipes to clean your hands, face, and other exposed parts of the body that were not covered by
2422 clothing.

³⁸ Brushing or shaking external clothing to remove contaminated dust.

2423 These actions can be performed at any location or at ad hoc locations set up by emergency response
2424 organizations to facilitate washing. Prior to opening these facilities, planners should ensure that an ample
2425 supply of replacement clothing, plastic bags, and wet wipes are available. First responders can also take
2426 these actions to reduce their exposure unless their safety officer provides other specific protocols.³⁹

2427 **SAMPLE SELF-DECONTAMINATION INSTRUCTIONS**

- 2428 Remove contaminated clothes and place them in a bag.
- 2429 Wash your body with warm water.
- 2430 Use cloth, sponge, soft brush, etc. to clean skin or clothing.
- 2431 Begin with mild agents, like soap and water.
- 2432 When showering, try to direct rinse water away from face and body. If washing your hair, do not use
2433 conditioner.
- 2434 Keep materials out of eyes, nose, mouth, and wounds.
- 2435 Avoid scratching, burning, or causing breaks in the skin.



2436 **Coordination Opportunity**

2437 Coordinate with safety officers to avoid contradictory protocols.

2438 For more detailed strategies for screening and decontamination, see Appendix 5.2: Strategies for
2439 Screening and Decontaminating People. These strategies vary for different populations—to understand how
2440 these populations differ, see Appendix 5.1: Impacted Populations.

2441 Additionally, planners must develop strategies to decontaminate animals, cars, buildings, etc. For more
2442 details, see Appendix 5.3: Screening and Decontaminating Service Animals and Pets and Appendix 5.4:
2443 Screening Contaminated Vehicles.

2444 **3. CRC and Mass Care Shelter Operations**

2445 CRCs and mass care shelters are distinct and complementary operations. CRCs provide population
2446 monitoring services, including contamination screening, decontamination, registration, and limited medical
2447 evaluation and care. Mass care shelters provide temporary housing, security, food, health and mental
2448 health services, ongoing health surveillance, and other similar services.

2449 It is not anticipated that CRCs or mass care shelters would be set up to receive injured individuals.
2450 However, plans should include transportation provisions for these facilities to transport victims in need of

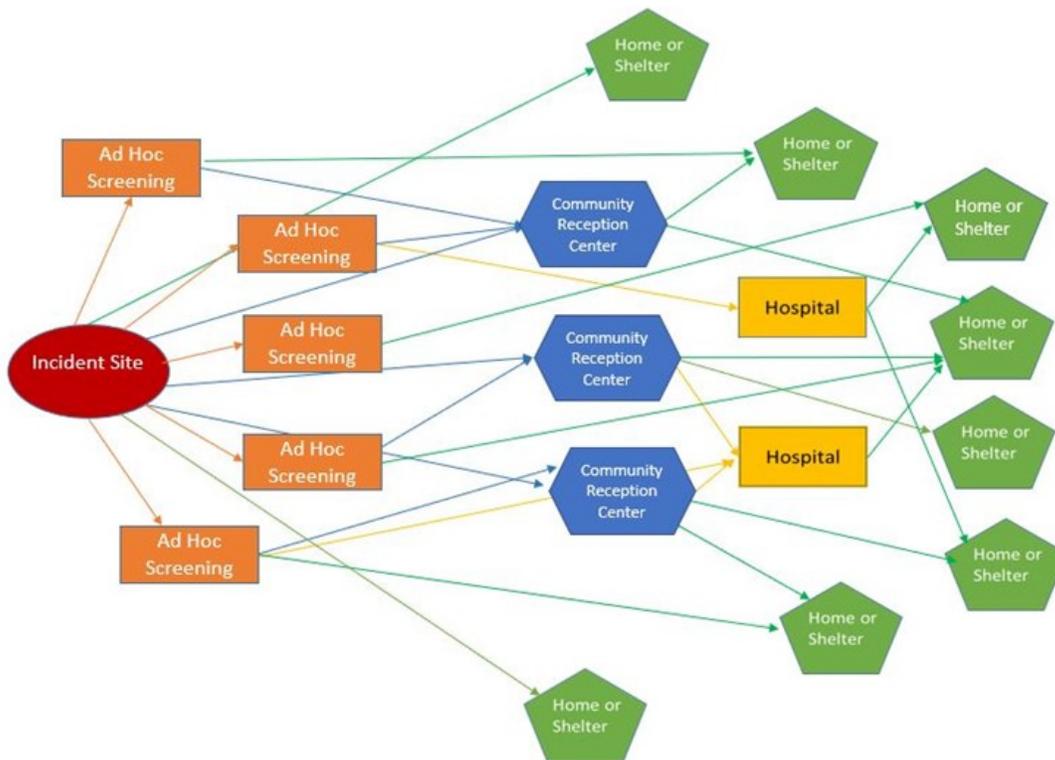
³⁹ Not likely in most settings, but some locations may be able to do early estimates of doses based on external exposure when location at time of incident and duration of exposure are known.

2451 immediate medical attention to healthcare facilities. The network of CRCs feeds into the larger network of
2452 mass care shelters, as illustrated in Figure 31.



Action Item

2454 Ensure plans include provisions to transport injured victims to healthcare facilities.
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2456

2457 **Figure 31: Possible pathways that people may follow to get screened for contamination.**

2458 Ideally, CRCs will process individuals before they report to mass care shelters; however, as shown in Figure
2459 31, mass care shelters may receive people who have not been screened at ad hoc locations or at CRCs.
2460 Regardless, there are special considerations for operating mass care shelters after a radiation emergency,
2461 to ensure the health and safety of mass care shelter residents and staff. The aforementioned *CDC Shelter*
2462 *Guide* provides additional guidance regarding these considerations, for planners, mass care shelter
2463 operators, and mass care shelter workers.

2464 3.1. Mass Care Shelter Considerations

2465 Jurisdictions should have pre-existing plans and procedures for establishing all-hazards, general
2466 population mass care shelters. Neighboring jurisdictions should also have plans to provide mutual aid to
2467 impacted jurisdictions, including provisions for mass care shelters for people evacuating the impacted area.

2468 CDC Shelter Guide recommendations may apply to emergency or temporary mass care shelters in areas with
2469 elevated radiation, but these types of mass care shelters are not the guide's focus. The mass care shelters
2470 described in the CDC Shelter Guide are long-term mass care shelters in areas where radiation levels are at
2471 or near natural background levels.

2472 Many organizations have mass care shelter plans for facilities in their communities. Depending on the nature of
2473 the radiation emergency, some of these facilities may not be suitable locations for mass care shelter
2474 operations due to utility outages, infrastructure damage, or elevated environmental radiation levels. Mass
2475 care shelter operators have standing protocols for managing and overcoming utility outages and
2476 infrastructure damage but may not be equipped or trained to assess environmental radiation levels. Mass
2477 care shelters should be established in uncontaminated or low background radiation areas, with
2478 environmental radiation levels below 1 $\mu\text{Sv/h}$ (0.1 mR/hr). In the first 24-48 hours after the incident,
2479 emergency managers and radiation control officials are likely to have access to detailed maps identifying
2480 radiation control zones, and they can help mass care shelter operators determine if their existing or
2481 proposed mass care shelter locations are in low background radiation areas.



What Would You Do?

2482

2483 How would you identify alternate mass care shelter locations if your previously established locations
2484 are not suitable due to their proximity to the impacted areas?

2485 Mass care shelters may initially be considered short-term operations, until environmental monitoring
2486 efforts near the incident site are completed and radiation control zones are established. Mass care shelters
2487 require relocation plans in the event they must move to lower background radiation areas. In certain
2488 circumstances, CRCs may not be established yet.

2489 Mass care shelters must prepare for residents with disabilities, functional needs, or access needs, in
2490 accordance with the Americans with Disabilities Act of 1990 (ADA). For examples of how to make mass
2491 care shelters more accessible, visit the CDC's [Disability and Health Emergency Preparedness](#) page,
2492 particularly the section on [Resources to Assess Shelters](#). Planners should also reference Appendix 5.3:
2493 Screening and Decontaminating Service Animals and Pets, to develop plans for people arriving with
2494 animals.

2495



Refer To

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2497 [Disability and Health Emergency Preparedness:](#)
2498 <https://www.cdc.gov/ncbddd/disabilityandhealth/emergencypreparedness.html>

2499 **3.1.1. KEY CONSIDERATIONS FOR SCREENING AND DECONTAMINATION AT MASS CARE**
2500 **SHELTERS**

- 2501 ▪ In instances of life-threatening or serious injuries, medical care takes priority over contamination
2502 screening and decontamination.

- 2503 ▪ Mass care shelters coordinating with and receiving people from CRCs must incorporate appropriate
2504 screening and decontamination into mass care shelter operations, if not already performed at the CRC.

- 2505 ▪ Mass care shelters may receive people before CRCs are available, necessitating screening people, service
2506 animals, pets, personal possessions, and vehicles for radioactive contamination and conducting
2507 decontamination, as appropriate.

- 2508 ▪ Screening criteria should be scalable and flexible, to adjust to varying incidents and screening capabilities.

- 2509 ▪ Decontamination plans should be scalable and flexible, to respond to different incidents and available
2510 decontamination capabilities.

- 2511 ▪ Mass care shelter staff working in contamination control zones should be screened for contamination
2512 at the end of their shifts and anytime they leave the contamination control zone. Subsequently, they
2513 should be decontaminated, if necessary.



2514 **What Would You Do?**

- 2515 ▪ How would you modify your shelter operations to allow access to people that have not been
2516 screened at a CRC?

- 2517 ▪ If you were working in a control zone and forgot to be screened for contamination prior to leaving,
2518 what would you do?

- 2519 ▪ How would you accommodate pets that were brought to the shelter? Would they be monitored
2520 and decontaminated? For relevant information, reference Appendix 5.3: Screening and
2521 Decontaminating Service Animals and Pets.



2522 **Action Item**

2523 Ensure decontamination messaging is clear and concise, avoiding jargon.

2524 **4. Long-term Registry and Follow-up**

2525 An important element of planning is establishing procedures and identifying resources for initiating a
2526 registry that will track all potentially affected people (responders, emergency workers, public, etc.).

2527 Similar to information collected at Points of Dispensing (PODs) during response to infectious diseases, a
2528 radiation registry must start at CRCs or mass care shelters, to identify and contact people who may require

2529 short-term medical follow-up or long-term health monitoring. The registry should collect basic contact
2530 information and radiation-related information, such as contamination measurements and distance from
2531 the incident, from all individuals who visit the CRC or mass care shelter. This includes the public, first
2532 responders, public health workers, and medical staff. Paper registries with digital data entered at a later
2533 time are a common option for CRC plans, as they require less trained staff. Tools such as the CDC CRC
2534 Electronic Data Collection Tool (CRC eTool); Agency for Toxic Substances and Disease Registry (ATSDR)
2535 Rapid Response Registry (RRR) and Epi Contact Assessment Symptom Exposure (EpiCASE); and NIOSH
2536 Emergency Responder Health Monitoring and Surveillance (ERHMS) system can also be used to gather and
2537 assess data, though these tools may require more staff and training to utilize.

2538 Key considerations for radiation registry establishment and data collection include:

- 2539 ▪ Identify and develop forms and/or database to be used for registration.
- 2540 ▪ Consider confidentiality and liability issues associated with registering, consulting legal personnel if
2541 necessary.
- 2542 ▪ Determine who will have access to registry data, how it will be stored securely, and how it will be archived.

2543  Action Item

- 2544 ▪ Identify and develop forms and/or databases to be used for registration.
- 2545 ▪ Determine who will have access to registry data, how it will be stored securely, and how it
2546 will be archived.

2547 State and local agencies are responsible for population monitoring following a nuclear or radiological
2548 incident, while CDC is responsible for assisting state and local agencies with long-term health monitoring,
2549 including establishing a radiation registry. ATSDR, an independent operating agency within HHS, is directed
2550 by congressional mandate to perform health surveillance and registries and may be a resource for state or
2551 locals to use to develop their own registries.

2552 A registry must be established as early as possible following a radiation emergency. Experience from
2553 past public health emergencies shows that congressional authorization, appropriation, and construction of
2554 code and statute to set up and operate a public health surveillance system or registry can take 1–2 years.
2555 Therefore, the process must begin during emergency response preparation planning. Additionally, during
2556 response, the emergency management community will be focused on life-saving activities, so they will be
2557 unable to focus on registry system decisions. Therefore, it is critical to plan for the radiation registry before
2558 an incident occurs. Analyzing effective methods to transfer information collected immediately after the
2559 incident to a registry may take months or years.

2560  Action Item

2561 Plan to establish a registry as soon as possible.

2562 Consider the following key factors when planning for a radiation registry:

- 2563 1. **Engage Stakeholders:** Bringing key stakeholders together before an emergency is essential for
2564 building trust, discussing scientific and sociopolitical challenges related to radiation registries, and
2565 identifying disagreements. Expected radiation registry stakeholders include anyone with a mission,
2566 interest, influence, or expectations related to the radiation registry.
- 2567 2. **Define the Purpose of a Registry:** The purpose of the registry defines who to enroll; methods to reach
2568 out to those individuals; what data must be collected; the consent, authorization, and legal
2569 requirements that govern the registry; and the resources needed to operate the registry, including
2570 personnel and funding.

2571 Potential purposes of a radiation registry:

- 2572 ▪ Medical monitoring of those who exhibit clinical symptoms related to ARS
- 2573 ▪ Health monitoring of those affected (exposure, contamination, mental health)
- 2574 ▪ Access to health care for those affected
- 2575 ▪ Research on radiation health effects
- 2576 ▪ Social recognition of the tragedy and the effects it has on the population
- 2577 ▪ Outreach to those affected, such as updates on scientific and medical developments or programs or
2578 policies relevant to the incident
- 2579 ▪ Financial compensation for victims
- 2580 3. **Identify Stakeholders' and Roles and Responsibilities:** Currently, the roles and responsibilities for
2581 establishing long-term health monitoring systems following a nuclear or radiological incident are not
2582 well-defined. Stakeholder agreement on roles and responsibilities prior to an incident produces an
2583 agreed upon framework to alleviate confusion, duplicative or conflicting efforts, and competition for
2584 scarce resources.
- 2585 a. The state and local public health community expects the federal government (CDC) to have a
2586 central role in setting up a radiation registry. Federal involvement could manifest a number
2587 of ways:
- 2588 i. CDC, with input from stakeholders, develops a framework for setting up a radiation
2589 registry, but its implementation is the responsibility of state or local health authorities.
- 2590 ii. CDC, with input from stakeholders, creates a radiation registry template and transfers it
2591 to state or local authorities to implement and operate the registry.
- 2592 iii. CDC, with input from stakeholders, implements and operates a centralized registry.
- 2593 iv. State or local health authorities perform data collection for the registry and transfer the
2594 data to CDC, which is responsible for operating a centralized registry and for reporting
2595 the adverse outcomes.

2596 Given that capabilities differ considerably across the United States, planners should identify their local and
2597 state capabilities to determine the most likely approach for their jurisdiction.

2598 **Key Pre-Incident Planning Activities for Setting Up Radiation Registry**

- 2599 ▪ Capture basic information of affected population
- 2600 ▪ Screen for radiation contamination and assess exposure
- 2601 ▪ Consider data system's needs

2602 4. **Link Immediate Response to Long-Term Follow-Up.** When developing a radiation registry, three key pre-
2603 incident planning areas can improve information transferring:

- 2604 ▪ Capture contact information on those affected - Although it is important to collect data for follow-up, it
2605 should not impact the responders' ability to accomplish life-saving tasks and early response priorities.
2606 If resources are limited, it is sufficient to collect only a few critical fields, such as name and contact
2607 information.
- 2608 ▪ Screen for radiation contamination and assess exposure - Screening for radiation contamination and
2609 early exposure assessment contributes to initial projections about the incident and its health effects on
2610 the affected community. They also provide an initial evaluation of the incident's effect on an
2611 individual's health. Therefore, screening for radiation contamination and early exposure assessment
2612 can affect decisions about the need for a registry and an individuals' participation.
- 2613 ▪ Consider digital data system's requirements - Transferring information collected during the early
2614 response phase to a registry may result in unanticipated inconsistencies across systems/entities. To
2615 the extent possible, planners should leverage existing systems to build a radiation registry.

2616 5. **Include Radiation Dose Threshold as a Registry Inclusion Criterion** – It is likely that the decision about
2617 what dose threshold (if any) is appropriate for a radiation registry in the U.S. will be a political decision,
2618 driven by social considerations and only partly informed by scientific evidence. Advanced planning can
2619 balance these considerations.

2620 Planners must find or develop registries and tracking systems that suit their jurisdictions particular needs.
2621 For reference, see Appendix 5.6: Available Tools for Tracking and Monitoring People.

2622  **Coordination Opportunity**

2623 State and local planners should coordinate with Radiation Control Program Directors to determine a
2624 preliminary radiation dose threshold for inclusion in a registry. Discuss with nearby states to ensure
2625 consistency in approach.

2626

Chapter 6: Communications and Public Preparedness

2627

2628 Though there are a variety of differing nuclear detonation scenarios, communications strategies for all
2629 scenarios are the same –immediate, clear, and instructive messages for public health and safety is the
2630 priority, regardless of size and HOB. The distinction between various types of bursts will ultimately affect the
2631 messages themselves because burst height affects key considerations like the presence or absence of fallout
2632 and the possibility of firestorms. The magnitude of the detonation will affect the number of people impacted.
2633 Even with variables, planners can learn to coordinate messages with technical bodies and distribute
2634 Integrated Public Alert and Warning System (IPAWS) and other public safety messages under the ICS.

2635



Coordination Opportunity

2636

Federal, state, and local resources must coordinate to send timely and accurate safety messages.

2637 Public affairs staff face a daunting challenge of addressing fear and grief while accurately describing
2638 protective actions, knowing that communication will play a critical role in potentially saving thousands of lives.
2639 Planners should inform staff that they do not have to start from zero. There are radiation communications
2640 experts across the country who can share best practices and case studies and help fill gaps in nuclear and
2641 radiological emergency preparedness and response communications. For more information, please reference
2642 the most current version of *Communicating in the Immediate Aftermath*.

2643



Refer To

2644

[*Nuclear Detonation Preparedness: Communicating in the Immediate Aftermath*](#)

2645

1. Pre-Incident Communications Planning

2646

1.1. Community Preparedness and Awareness

2647 Radiation is often feared and not well understood. In a nuclear detonation scenario, this is compounded.
2648 Most members of the public do not plan for or know how to respond to this type of hazard. In this scenario,
2649 preparedness can save more lives than any other aspect of a response.

2650 The public's perception of risk in a nuclear detonation scenario evokes extremely strong emotions because
2651 every factor that increases risk perception is present in a nuclear detonation scenario (Covello &
2652 Sandman, 1988). Nuclear detonations are hard to understand, imposed, and catastrophic—and a lack of
2653 knowledge about the subject makes it difficult for people to feel like they are in control. The future is
2654 uncertain, the scenario is unfamiliar, and the hazard is man-made. All these factors make messaging

2655 during radiation emergencies incredibly difficult. However, while it will always be imposed and
2656 catastrophic, we can help increase the public’s perception of control and familiarity through pre-incident
2657 education.

2658 It is the responsibility of emergency planners, public information officers (PIOs), community leaders, and
2659 emergency and first response personnel to effectively communicate why preparing for a nuclear
2660 detonation scenario is essential to survive it. Without pre-incident knowledge, key messaging, and
2661 preparedness steps, people will likely follow the instinct to run from danger, potentially exposing themselves
2662 to fatal doses of radiation that could be avoided by sheltering.

2663 Planners can perform two key preparation activities to enhance community preparedness:

2664 **1.1.1. PLAN AND EXECUTE NUCLEAR DETONATION PREPAREDNESS EDUCATION CAMPAIGNS**
2665 **RELATED TO OTHER HAZARDS.**

2666 **Pre-incident preparedness is a difficult task, regardless of hazard.** There is a legacy of public nuclear
2667 preparedness campaigns, such as the Cold War’s ‘duck and cover’ that leave the public skeptical of nuclear
2668 detonation preparedness messages⁴⁰. In addition, with a public that associates nuclear detonations with
2669 certain death, the sense of futility, fatalism, and hopelessness severely impacts their desire and ability to
2670 absorb information and follow instructions.

2671 **Gather support for preparedness campaigns from a coalition of decision makers and other public health**
2672 **agencies in your community.** Identify the best spokespeople in these groups to assist you in broad-reaching
2673 preparedness campaigns.

2674 **Leverage all-hazards messaging in preparedness outreach.** While these campaigns are necessary, they
2675 may be difficult to execute without causing unnecessary concern. Because of resistance to open
2676 discussions about nuclear detonations, emergency management agencies and public affairs staff must
2677 integrate nuclear detonation messaging into all-hazards messaging.

2678 **Utilize National Preparedness Month each September to include nuclear detonation preparedness into**
2679 **larger preparedness campaigns.** People are less likely to resist learning about protective actions for a
2680 nuclear detonation if they understand that they are applicable to other, more familiar emergencies. If your
2681 emergency management group is encouraging people to make an emergency kit or prepare financially for
2682 an emergency, adding another hazard to the list for which these actions are protective is less likely to
2683 frighten people. It may be useful to introduce CBRN preparedness actions together. Nuclear detonation
2684 preparedness can also be integrated into wider radiological and nuclear preparedness. For example, initial
2685 protective actions for a nuclear detonation and for a dirty bomb scenario are very similar: people must “Get
2686 Inside, Stay Inside, and Stay Tuned” for more instructions.

⁴⁰ Pulled directly from the 2010 document, which cited Homeland Security Initiative’s Nuclear Incident Communication Planning: Final Report (Homeland Security Institute. 2009. Nuclear Incident Communications Planning: Final Report. Department of Homeland Security, Office of Health Affairs. RP-08-15-03)

2687



Action Item

2688

Leverage National Preparedness Month for public outreach and preparedness campaigns.

2689

Use simple, action-oriented language to help your constituents absorb preparedness information. In

2690 communicating preparedness information, your strategy and messages must use basic, non-technical

2691 language that is easy to understand and translate. Focusing on action helps constituents feel more in

2692 control and helps them retain information to make more informed decisions. Empathetically address the

2693 public's fear and concern; expressing empathy validates strong emotion and increases public trust.

2694



Action Item

2695

Use simple, action-oriented, empathetic messages to encourage preparedness.

2696

Reinforce and encourage adoption of emergency communication methods. Preparedness campaigns

2697 should include information about communications methods that emergency managers and responders will

2698 use to reach the public. Campaigns should describe local emergency notification platforms, meanings of

2699 various emergency siren tones, and continued encouragement of hand-crank radio acquisition.

2700

Leverage existing NPP preparedness campaigns and communications. NPPs and the FEMA's Radiological

2701 Emergency Preparedness (REP) Program provide radiological preparedness information to those living near

2702 commercial nuclear power facilities. The REP Program has worked with schools to incorporate

2703 preparedness information on school calendars and book bag labels to reach out to both parents and students.

2704



Coordination Opportunity

2705

- Coordinate with FEMA's REP Program to leverage existing NPP preparedness campaigns and communications.

2706

2707

- Coordinate with community leaders and influencers to make inroads to different organizations in your jurisdiction

2708

2709

1.1.2. PLAN FOR TEACHABLE MOMENTS AND APPROVE TEACHABLE MOMENT STRATEGIES

2710

AND MESSAGES IN ADVANCE.

2711 A teachable moment is “an event or experience which presents a good opportunity for learning something

2712 about a particular aspect of life”(Oxford, 2021). In these moments, something has happened to remind the

2713 public about nuclear detonations, but there is no threat. During teachable moments, heightened

2714 awareness of a threat or emergency increases the public's desire for knowledge about how to protect

2715 themselves and their loved ones. Teachable moments are an opportunity for emergency planners and

2716 public information/affairs staff—in these moments, the public is more willing to listen to preparedness

2717 messages without being frightened by the messages themselves.

2718



Action Item

2719

Prepare in advance to leverage teachable moments quickly and effectively.

2720

Be alert for teachable moments. It is critical to have prepared messages, dissemination outlets, and strategies approved in advance, because increased attention will be brief. Have prepared messaging available and approved so the window of opportunity to educate is not missed.

2721

2722

2723

Recognize that teachable moments may be sparked by different media. As with your preparedness campaign, it may also be useful to group CBRN incidents together. For instance, television shows, movies, podcasts, and other media may discuss a chemical emergency and gain public popularity. Remind residents that, should any type of CBRN incident occur, they should stay inside a sturdy building and monitor information from public officials.

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What Would You Do?

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A popular television show depicted a terrorist improvised nuclear device (IND) incident in a way that increased public curiosity about surviving an IND. What messages do you have prepared, and who would have to approve them for use to increase knowledge and preparedness?

2730

2731

2732

Gather organizational support and approval before a teachable moment occurs. Because we cannot predict what might spark a teachable moment, communicators should prepare reassuring and instructive messages with fill-in-the-blank spaces for specific details based on the teachable moment. Discuss your strategy with your management and chain of command and emphasize how important these moments are for broad awareness of safety actions following a nuclear detonation.

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Refer To

2738

Access and Functional Needs Toolkit: Integrating a Community Partner Network to Inform Risk Communication Strategies

2739

2740 1.2. Audience Assessment and Preparation

2741

As with any response, it is vital to know who is in the affected area to adequately meet survivor needs and save lives. To communicate effectively, get as specific as possible when defining different audiences and include workers who are likely terrified and grieving but still need to go to work. To reach all audiences, you may need to coordinate with people outside of your direct response community for help. Your existing knowledge as a communicator in your jurisdiction is the building block for all communications planning. It is important to know population density, languages spoken, number of commuters and tourists, previous experience with environmental or physical emergencies, and commonly crowded places. It is important to

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2748 know who community leaders are, and who may be a good spokesperson during an emergency. This
2749 information can help for all types of emergencies.

2750  Refer To

- 2751 ▪ Communicating Radiation Risks, EPA, 2007: [https://www.epa.gov/sites/default/files/2017-](https://www.epa.gov/sites/default/files/2017-07/documents/epa_communicating_radiation_risks.pdf)
2752 [07/documents/epa_communicating_radiation_risks.pdf](https://www.epa.gov/sites/default/files/2017-07/documents/epa_communicating_radiation_risks.pdf)
- 2753 ▪ *Community Emergency Planning Toolkit for NYC Community and Faith-Based Networks*, New York
2754 City, 2019: <https://www1.nyc.gov/site/em/ready/community-preparedness.page>

2755 Aim to get input on preparedness efforts from outside your current emergency response community; the
2756 New York City Community Emergency Planning Toolkit is an excellent reference to begin preparedness
2757 conversations with a variety of stakeholder groups.

2758 **1.2.1. COMMUNICATING WITH PARENTS OF CHILDREN IN SCHOOLS AND DAYCARES WILL BE**
2759 **EXCEPTIONALLY DIFFICULT AND CONTRADICT PARENTS' INSTINCTS TO REUNITE**
2760 **WITH THEIR CHILDREN IMMEDIATELY.**

2761 **Develop communication strategies for parents of children in schools and daycares.** Your jurisdiction's
2762 outreach strategy must communicate the necessity of staying indoors, even when children are not with
2763 their parents. Preparedness messaging must incorporate school and daycare safety plans and explain the
2764 dangers of parents attempting to pick up their children.

2765  Coordination Opportunity

2766 Work with schools and daycares to ensure parents do not attempt to retrieve children in unsafe
2767 conditions.

2768 **Incorporate nuclear detonation preparedness into existing emergency drills.** While schools and daycares do
2769 not exercise nuclear detonation drills specifically, they likely exercise shelter-in-place drills for tornadoes,
2770 earthquakes, and other severe weather incidents. At a minimum, school administrators should know how
2771 these relate to nuclear detonation protective actions.

2772 **1.2.2. IDENTIFY RESPONDER AUDIENCES AND PREPARE MESSAGING FOR THOSE THAT NEED**
2773 **TO SHELTER FOLLOWING A DETONATION.**

2774 **Everything in this document is considered critical to saving the lives of people in the SDZ, MDZ, LDZ and**
2775 **DRZ. However, responders cannot save lives if they are exposed to fatal levels of radiation or otherwise**
2776 **disabled. Responder messaging must be prioritized, to protect them and enable their lifesaving work.**

2777 **Shelter-in-place messaging for responders within the DRZ is critical.** It is critical that first responders, who
2778 train to go into responses, remain sheltered during the first 24 hours of response if they are in the DRZ.
2779 Utilize communications skills to train responders in a manner that emphasizes patience, even in the face

2780 of a nuclear detonation, is required to save responder lives so they can save others. Be sure to include
2781 how responders will be notified that they are in the DRZ.



Action Item

2782

2783 Develop communications strategies that specifically address first responders.

2784 **Reference federal radiation exposure guidance and safety guidelines in communications for responders.**

2785 Many emergency workers are not familiar with radiation protection and may not be comfortable working in
2786 a radiation environment. Ensure responders understand the differences in radiation risks during a nuclear
2787 detonation relative to other radiation-related emergencies. Responders must be properly informed about
2788 the risks associated with the areas they may be working in. Just-in-time training material is critical to
2789 address this issue.



Refer To

2790

2791 [*PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*](#)

2792 **Communications staff's ability to define audiences will be useful for first responder community outreach.**

2793 While most pre-incident responder education and training is performed by emergency managers and first
2794 responder groups, it can be enhanced by involving skilled communications experts. Communications staff
2795 have specific message development skills to assist trainers, supervisors, and planners with language and
2796 tone choices to enhance messaging, even if others will ultimately be responsible for these conversations
2797 and trainings.

2798 **Identify and educate non-traditional emergency workers.** Outreach to non-traditional emergency workers,
2799 such as public works employees, must emphasize their critical role in response and explain the risks
2800 associated with it. Engaging these groups early, before an incident happens, is critical for anticipating their
2801 needs during response (Benedek & Fullerton, 2007). When analyzing community needs, note places and
2802 services that are visited daily, to predict potential non-traditional emergency responders.



Action Item

2803

2804 Identify and educate non-traditional emergency workers critical to emergency response.

2805 **Develop communications to ensure responders and their families understand radiation risks and other**

2806 **response hazards.** Responder's families will be concerned about their loved ones working in the area.
2807 Communication is important for families to understand guidelines and protections in place to minimize
2808 responder dose and risk.

2809 **1.3. Interjurisdictional Relationships and Memoranda of Understanding (MOUs)**

2810 When faced with this type of resource-straining incident, officials and responders must know who to rely on for
2811 assistance. Cultivating and maintaining assistance relationships with neighboring towns, cities, and
2812 counties, as well as state and federal response organizations, is critical to ensure this aid.

2813 **1.3.1. PRE-ESTABLISHED RELATIONSHIPS WITH NEIGHBORING COMMUNITIES ARE VITAL TO**
2814 **FACILITATE MESSAGE DISSEMINATION SUPPORT DURING NUCLEAR DETONATION**
2815 **RESPONSE.**

2816 **Share and coordinate nuclear detonation plans with neighboring jurisdictions. Coordination for a nuclear**
2817 **detonation response is similar to coordination for other incidents and will assist your jurisdiction during**
2818 **other responses.** Planners should consider exercising plans with these jurisdictions and establishing them
2819 as trusted agents in your emergency management structure. These relationships enable neighboring
2820 townships or counties to effectively reach your communities. While doing so, familiarize neighboring
2821 jurisdictions with your community’s news acquisition preferences. Understanding how your residents get
2822 news will empower other jurisdictions to effectively respond in your jurisdiction. Identifying a multi-
2823 jurisdictional or regional approach to communications is critical to immediately publish time-critical safety
2824 messages.



2825 **Coordination Opportunity**

2826 Coordinate nuclear detonation plans with neighboring jurisdictions that will be tasked to support your
2827 jurisdiction following a nuclear detonation.

2828 **Review existing agreements to ensure communications and public information support are included.**

2829 Establish the importance of communication in saving lives early in the planning process. Doing so will
2830 assist you throughout a response.

2831 Detectable radiation downwind of the detonation will likely cause concern in members of the public and in
2832 responders. Though the detonation will primarily and profoundly impact the area in which the detonation
2833 occurs, a possibility of detectable radiation levels traveling to nearby jurisdictions is certainly present.
2834 Emergency planners and public information officers in nearby jurisdictions should be aware that detectable
2835 radiation will vary depending on weather and atmospheric conditions and prepare for an onslaught of
2836 concerned questions from members of the public, exacerbated by the trauma of a domestic nuclear
2837 detonation. Nationwide, emergency managers should remain aware of federal modeling and monitoring for
2838 radioactive material.

2839 **1.3.2. FEMA'S RADIOLOGICAL OPERATIONS SUPPORT SPECIALIST (ROSS) PROGRAM CAN**
2840 **ASSIST WITH TECHNICAL COMMUNICATIONS ASSISTANCE AND SHOULD BE**
2841 **INCORPORATED INTO PLANS.**



Refer To

2843 FEMA's ROSS Information Sheet: [https://www.fema.gov/sites/default/files/2020-07/fema_cbrn-](https://www.fema.gov/sites/default/files/2020-07/fema_cbrn-ross.pdf)
2844 [ross.pdf](https://www.fema.gov/sites/default/files/2020-07/fema_cbrn-ross.pdf)

2845 **Ensure radiation expertise is available to support message development.** While not every jurisdiction has a
2846 radiation expert on staff, this expertise is critical to assist communications staff with their messaging. This
2847 expert input is integral for explaining radiation risks, clarifying protective actions, and addressing concerns
2848 about radiation doses. The value of radiation experts for this response cannot be understated. Jurisdictions
2849 should identify these experts within their community and address any expertise gaps that may exist.

2850 **Integrate ROSS into plans to fill identified gaps.** Plans should include coordination with the ROSS program.
2851 ROSS can assist communications staff with radiation technical support for planning and response
2852 operations. ROSS are trained to review information to provide situational awareness and support message
2853 consistency across responding jurisdictions. Connect with the ROSS program by emailing **FEMA-**
2854 **ROSS@FEMA.DHS.GOV.**

2855 **2. Immediate Response Communications Priorities**

2856 It will be incredibly difficult to reach those affected by a nuclear detonation. Even after natural disasters, it can
2857 take days to months to fully restore cellphone capabilities. To fully appreciate the importance of pre-incident
2858 preparedness, it is necessary to understand the impacts that nuclear detonations have on communications
2859 infrastructure. Communication capabilities following a nuclear detonation depend on the amount of
2860 remaining infrastructure, and pre-existing community plans and preparations. For more information about
2861 communications capabilities following a nuclear detonation, see Chapter 7.

2862 **2.1. Safety Instruction Dissemination**

2863 Even if there is a total shift in public awareness of nuclear detonation preparedness actions, the public will
2864 require just-in-time messages that direct them to get inside and stay inside, self-decontaminate, and wait
2865 for further instructions. **Your jurisdiction's ability to provide those messages hinges on three critical factors:**
2866 **advance preparation of messages, immediate dissemination of messages, and redundant dissemination**
2867 **outlets to compensate for severely damaged infrastructure.**

2868 **2.1.1. PRE-SCRIPTED AND APPROVED MESSAGING INCREASES PUBLIC COMMUNICATION** 2869 **EFFECTIVENESS WHEN MINUTES MATTER.**

2870 **Leverage pre-scripted, vetted, and federal agency approved messages.** FEMA's *Improvised Nuclear Device*
2871 *Response and Recovery: Communicating in the Immediate Aftermath* contains anticipated questions and
2872 answers for use immediately following a nuclear detonation. These messages have been reviewed by all
2873 federal response agencies for immediate use in your jurisdiction. This communications guide answers

2874 many anticipated questions, and provides scientifically accurate safety messages in simple, effective
2875 language. Your public affairs staff should become familiar with and practice using this document.

2876  Refer To

2877 FEMA's *Improvised Nuclear Device Response and Recovery: Communicating in the Immediate*
2878 *Aftermath* [2880 **Adapt and create messages that address the concerns of and populations in your community specifically.**
2881 Existing pre-scripted messages are not exhaustive of all critical communications considerations. There are
2882 many questions that depend on state and local response, as well as specific geographical questions that
2883 cannot be answered at the federal level. Draft a list of anticipated public questions based on the interests
2884 and needs of your community. Use anticipated questions and pre-scripted messages in exercises. Include
2885 members of the response community from all levels—decision makers, first responders, public works staff,
2886 and communicators—and use this opportunity to gather additional questions.](https://www.fema.gov/sites/default/files/documents/fema_improvised-nuclear-
2879 <i>device_communicating-aftermath_june-2013.pdf</i></p></div><div data-bbox=)

2887  Action Item

2888 Ensure messaging addresses the unique concerns of your community.

2889 **Use plain language and message mapping tools to develop effective communications.** When anticipating
2890 questions and scripting answers, consider both broad audiences (people in the blast damage zones, the
2891 DRZ and surrounding area, and the national and international community) and targeted audiences (non-
2892 English speakers, hospital and nursing home staff and patients, people experiencing homelessness,
2893 farmers, etc.). For messages to be effective, they must be understood by the intended audience. It is
2894 important to keep messages simple, accurate, and consistent, using plain language as much as possible.
2895 Research shows that some common emergency response terms and phrases, like ‘shelter-in-place,’ are not
2896 understood by the public. Avoid jargon, technical terms, and acronyms.

2897  Refer To

2898 *Communicating Radiation Risks*, EPA, 2007: [2900 **Prepare people for safety guidance and instruction updates.** Emergencies evolve over time, and safety
2901 messages will be updated frequently to reflect changing conditions and new information. In messaging
2902 studies, respondents preferred the phrase “instructions will be updated” over “instructions may change,”
2903 because it contextualized why safety instructions may evolve throughout response. “Updated” implies
2904 further information, while “change” implies instructions were wrong. \(National Center for Environmental
2905 Health Radiation Studies Branch & CDC, 2011\)](https://www.epa.gov/sites/default/files/2017-
2899 <i>07/documents/epa_communicating_radiation_risks.pdf</i></p></div><div data-bbox=)

2906 **2.1.2. DISSEMINATE SAFETY MESSAGES ACROSS ALL POSSIBLE CHANNELS TO SAVE LIVES.**

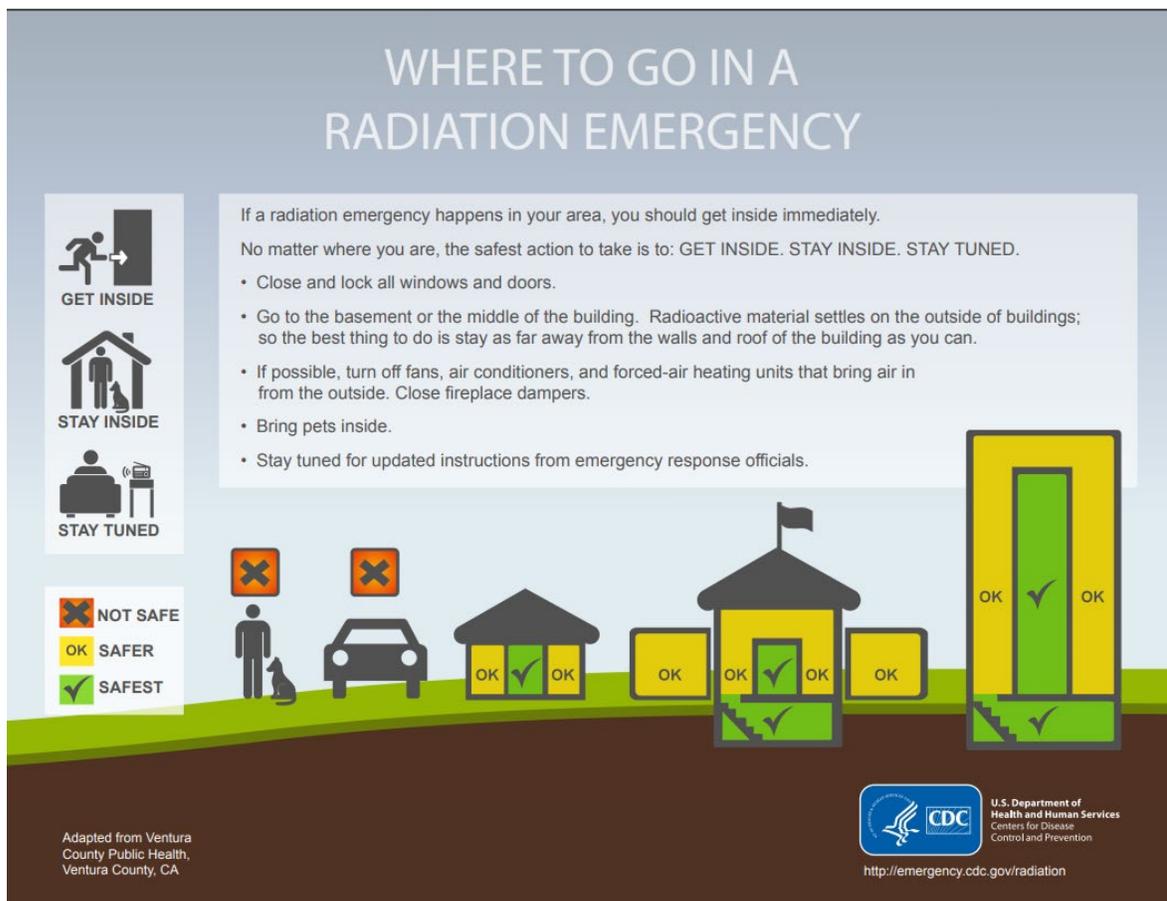
2907 Based on modeling from DOE National Laboratories, deaths and severe injuries from fallout can be almost
2908 eliminated if people get inside before an incident happens. Likewise, deaths and injuries are drastically
2909 reduced if people receive the message soon after a detonation occurs. For more information on adequate
2910 shelter, refer to Chapter 3.



2911 **Action Item**

2912 Prepare messages for immediate dissemination across all possible channels.

2913 **Encourage all jurisdictions to disseminate a consistent early message of “Get Inside, Stay Inside, Stay**
2914 **Tuned.”** DHS published an update to ESF-15: SOP in July 2019 establishing that response organizations at
2915 all levels of government are empowered to broadcast immediate safety messages. If there has been a
2916 confirmed nuclear detonation, DHS guidance says that “all Federal, state, local, tribal or territorial agencies
2917 with appropriate public health and safety missions should disseminate the ‘Get Inside, Stay Inside, and
2918 Stay Tuned’ message through all available communication channels. This message is approved for
2919 immediate dissemination.”



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Figure 32: Example infographic showing where to go during a radiation emergency developed by the CDC (CDC, 2020).

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Action Item

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Ensure plans include consistent early dissemination of “Get Inside, Stay Inside, Stay Tuned.” messaging.

2926



Refer To

2927
2928

FEMA, Emergency Support Function 15 - External Affairs, Annex N:
https://www.fema.gov/sites/default/files/2020-07/fema_ESF_15_External-Affairs.pdf)

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Coordination is critical to ensure initial protective action information reaches affected populations immediately following a nuclear detonation. The first action for every local, state, and federal agency is to push safety messages through every possible outlet. Repeating messages through all levels of government reinforces that the messages are credible. When cultivating relationships with nearby jurisdictions, community organizations, and federal and state partners, establish how essential repeated and consistent safety messages are. Your organization’s relationship with others may be the difference between people seeing a single message and disregarding it, or seeing repetitions of the same message and following the instructions

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Plan for variable communication within the impacted area. There will be significant damage to infrastructure that will affect your ability to communicate with incident command staff, responders, the public, and other jurisdictions. Reference the Communications Infrastructure section later in this chapter for more information.

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Develop a plan for preapproved message distribution before ICS or JIC/JIS (Joint Information System) structures are activated. It is necessary to prepare plans that authorize response personnel to disseminate messages when they are unable to contact an EOC or JIC/JIS. Include these specific communications tasks in planning, incorporating relevant implications and considerations.

2945



What Would You Do?

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What would you do if you were unable to communicate with your approval chain for message delivery? How would you ensure critical life safety messages were disseminated?

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2.1.3. AGILE AND IMMEDIATE COMMUNICATIONS CHANNELS ARE INTEGRAL AND NECESSARY TO SEND OUT FREQUENT UPDATES.

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Cultivate a social media presence and following before an incident, to build trust and confidence. Using consistent best practices, communications staff should disseminate safety messages on all the platforms your agency or jurisdiction has a presence on. Planners should ensure their agencies and jurisdictions have verified social media accounts and are providing regular updates through these channels. Knowing

2954 where to look for information reduces the public’s reaction time—in a nuclear detonation scenario, these
2955 minutes matter.



Action Item

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2957 Invest in social media development now— cultivate a social media presence and following before
2958 an incident, to build credibility for that channel.

2959 **Predetermine communication channel options based on expected nuclear detonation impacts and pre-**
2960 **identified preferred message channels.** Your jurisdiction’s plans should include a standard operating
2961 procedure (SOP) regarding safety instruction communication methods. Prioritize platforms your
2962 constituents visit and use frequently. Make sure to publish safety messages across all the platforms your
2963 jurisdiction uses. These methods should be informed by community usage of and familiarity with specific
2964 platforms and outlets. Additional, alternate communication methods must be publicized in preparedness
2965 campaigns, so people know where to find information if certain systems are down.

2966 This planning guidance outlines zones where the types and severity of impacts can be estimated.
2967 Planning should consider of each of these zones, and structure specific communication pathway priorities
2968 around them. For example, because most communication modes will be impaired in the MDZ, deployable
2969 cell towers or flyover messaging may be prioritized.

2970 **Incorporate procedures for communications staff to monitor and quickly correct conflicting or inaccurate**
2971 **information.** With many response organizations and worldwide interest in nuclear detonations, there is a
2972 high likelihood of conflicting and incorrect information dissemination. Communications staff should
2973 incorporate appropriate subject matter experts to quickly assess questionable messages and assist with
2974 drafting messages to counter or augment others.



What Would You Do?

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2976 If social media posts encouraged people to drink iodine, to protect themselves from radiation, what
2977 would you do? How would you confront this rumor?

2978 **Prioritize frequent updates to limit information obtained from unofficial sources.** Frequent updates, even
2979 when no new information is available, is recommended to ensure people continue to seek information
2980 from you instead of unofficial sources. Set expectations for update timing early on and meet them. Simple
2981 explanations of ongoing work, why it is valuable for the public, and how it informs safety instructions
2982 provides reassurance.

2983 **Utilize family and social connections in your community to share important messages.** As people attempt to
2984 reach family and friends in the affected area, it is critical that they have the most up-to-date safety
2985 instructions, because they may be the first to reach those sheltering in the affected area. You can address
2986 these audiences nationally and encourage them to relay safety messages.

2987 **2.1.4. GEO-TARGETING SHOULD BE A COMPONENT OF YOUR COMMUNICATIONS STRATEGY.**

2988 Wireless Emergency Alerts (WEA) is a public safety system that allows customers with compatible mobile
2989 devices to receive geographically targeted, text-like messages alerting them of imminent threats in their
2990 area. This can be leveraged in different stages of a response. For example, if your jurisdiction has
2991 determined that people in the affected area should self-evacuate, you can precisely target people in those
2992 locations to notify them to evacuate and avoid the DRZ. Chapter 7 provides additional details about WEAs.



2993 **Action Item**

2994 Include geo-targeting in your communications strategy.

2995 **Plan to send different messages to varying impact areas, to ensure proper action is taken in each zone.**

2996 After “Get Inside, Stay Inside, Stay Tuned” is immediately disseminated, communications must transition to
2997 specifically address each zone within the affected area. Messages should be drafted for each area, and
2998 targeted message delivery systems should be established.

2999 **Practice coordinating and delivering targeted messages.** Similar to testing tornado sirens, testing WEA
3000 capabilities within your community can help identify gaps and capabilities and may be a good way to
3001 engage your jurisdiction in preparedness efforts during National Preparedness Month. Practicing geo-
3002 targeted message deployment is necessary to effectively utilize this strategy during an emergency.

3003 **Engage local businesses and organizations to practice amplifying emergency messages.** Reach out to other
3004 businesses that record customer contact information. Is there a local coffee shop with an online loyalty
3005 program that everyone visits before going to work? Local organizations may be able to assist in message
3006 delivery, but relationships must be established before the incident occurs.



3007 **Coordination Opportunity**

3008 Include local businesses in exercises to build trust and practice emergency communication. Do
3009 educational outreach via talks and demonstrations of equipment and monitoring.

3010 **2.1.5. EXPLAINING HEALTH RISKS AND BENEFITS RELATED TO CRITICAL DECISIONS IS**
3011 **CRUCIAL FOR PUBLIC ACCEPTANCE AND COMPLIANCE WITH SAFETY**
3012 **INSTRUCTIONS.**

3013 **Understanding radiation risk is crucial for public and responder safety instruction compliance.**

3014 Communicating radiation risks and protection principles is necessary for both responders and the public to
3015 understand that their actions can protect them from short- and long-term health effects. Depending on the
3016 protective actions, even a brief explanation can increase compliance. Relating protective actions to other
3017 incidents with similar guidance, like sheltering for tornadoes, can also increase understanding and
3018 compliance with safety instruction. Radiation risk and simple technical messaging are integrated into all
3019 the federal government’s pre-scripted radiation emergency messaging but should be noted in your
3020 jurisdiction’s plans as well.

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Action Item

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Include risks and benefits explanations in messaging to increase public acceptance and compliance with safety instructions.

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Integrate radiation technical advisors or ROSS as early as possible, to translate technical information and inform communicators. Identify radiation professionals in your community or state. These individuals can be found in your state radiation control program, established dose assessment or radiation advisory groups, or ROSS in other radiation-related industries. ROSSs are specifically trained to simplify complex radiation content into simpler terms and assist with public messaging efforts. Some safety actions may seem contradictory to your community; work with a technical expert to develop accurate, clear messages that deconflict identified issues.

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Emphasize communications skills across disciplines, not solely the public information field. In an emergency, everyone involved in response is a potential spokesperson—to the public, to the media, and to other responders. Communications staff should work with technical experts, first responders, and elected officials, all of whom may be the most trusted spokespeople, to provide media training and practice before an incident occurs.

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Coordination Opportunity

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Anticipate technical support from radiation specialists and incorporate them in communications plan.
It is critical for everyone to practice effective communication techniques, not just communications staff—train personnel in other response positions.

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2.1.6. DETERMINE A PUBLIC INFORMATION APPROVAL CHAIN WITHIN YOUR ORGANIZATION AND EXERCISE THE PROCESS REGULARLY.

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Develop a message review plan, with appropriate approval levels, and exercise this plan frequently. Many jurisdictions already have message review plans or approval chains that have been used in the past. The scale of a nuclear detonation response will be much larger than any other emergency your jurisdiction has planned for or responded to. In your plan, consider additional steps that may be necessary to review and approve messages before dissemination. **Reduce the amount of time it takes to create and deploy a message by briefing approvers on needed messaging before an emergency happens.**

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Plan for frequent review and updates as message needs change. Data will be gathered by field teams and analyzed by scientists in increasing amounts as the response continues. Updates to current messages will be necessary, even if changes are limited. Review previously approved messaging on a regular basis to ensure accuracy. Address this with decision makers in your review chain, so they anticipate reviewing and approving similar messages multiple times.

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Action Item

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Develop a public information approval chain and exercise the process frequently.

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2.2. Communications Infrastructure

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The blast effects of a nuclear detonation will critically damage cell towers, telephone lines, power lines, and other integral communications infrastructure such as backhaul and portions of the core network. Therefore, replacing cell towers and telephone lines alone may be insufficient to restore communications infrastructure. This is, and will remain, the biggest challenge in communicating with the public following a nuclear detonation.

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2.2.1. INFRASTRUCTURE DAMAGE WILL BE THE MAIN CHALLENGE IN COMMUNICATING WITH THE AFFECTED COMMUNITY AND RESPONDERS.

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Preparedness is the only way to ensure community awareness and adoption of safety instructions. To ensure your community knows what to do—without prompting from a website, WEA, or social media post—prepare your community in advance to know signs of a nuclear detonation and proper protective actions.

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Providing appropriate information ahead of time ensures proper information is disseminated during response. Well-briefed response staff are integral to communications efforts because the first information people receive may be from first responders in the affected area. Developing and distributing key information cards for responders can help first response teams spread critical safety messages within affected areas.

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Prioritize communications infrastructure restoration. Along with commercial systems, public safety systems, like land and mobile radio and 911 call centers, may suffer communications failures. Though public safety systems may be hardened against blast damage, residents' ability to connect with the designated Public Safety Answering Point (PSAP)⁴¹ may be hindered by cell tower or telephone pole damage. These systems are critical for emergency responders and need to be restored as quickly as possible. Additionally, when responding to a major disaster, such as a nuclear detonation, FEMA activates the Communications Annex of the NRF, ESF-2. ESF-2 enables coordination with the private sector, state, and local entities to restore commercial communications infrastructure, public safety networks, and emergency responder networks.

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Identify less-common, low-tech methods for communicating in severe environments. Low-tech methods, such as sirens, HAM radio, and flyer drops, will likely be necessary to reach people in the immediately affected area following a nuclear detonation.

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⁴¹ For more information on PSAPs, see Chapter 7.

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Refer To

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[ESF-2 - Communications Annex https://www.fema.gov/pdf/emergency/nrf/nrf-esf-02.pdf](https://www.fema.gov/pdf/emergency/nrf/nrf-esf-02.pdf)

3085 **2.2.2. CELL TOWERS WILL BE OVERLOADED WITH PHONE CALLS AND TEXT MESSAGES,**
3086 **MAKING COMMUNICATIONS SLUGGISH.**

3087 Plans must emphasize sending protective action and safety messages through all available channels. It
3088 will be unclear which methods work, but understanding the challenges posed by certain methods is
3089 critical.

3090 **Encourage texting over calling.** Without exception, emergencies prompt an avalanche of calls, texts, and
3091 social media messages to those in affected areas. Most response organizations have pre-scripted, or
3092 previously published messages, indicating people should use text messaging instead of calling to increase
3093 their chance of connecting with loved ones.

3094 As mentioned later in Chapter 7, FEMA IPAWS' WEAs use Short Message Service-Cell Broadcast (SMS-CB),
3095 a one-to-many service, that simultaneously delivers messages to multiple recipients in a specified area. By
3096 using SMS-CB as the delivery service technology, WEAs avoid mobile device congestion issues experienced
3097 by traditional voice and text messaging SMS-Point to Point (SMS-PP) alerting services.

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Action Item

3099 Prioritize texting systems over calling systems when attempting to reach those in the affected
3100 area.

3101 **2.2.3. COORDINATE WITH CELL SERVICE PROVIDERS IN YOUR AREA. CELL TOWERS**
3102 **GENERALLY HAVE TWO BRANCHES OF UTILITY: VOICE AND TEXT, AND DATA.**

3103 During emergencies, carriers will reallocate branches to support 911 and emergency calling, sometimes
3104 completely cutting off data utility to give emergency calls and text messages a better chance of connecting.
3105 This reallocation can be automatic or controlled manually. Planners should talk to the providers in their area
3106 to determine what the provider's trigger points are, what considerations the provider makes in allocation
3107 during emergencies, and what geographic considerations may need to go into connectivity planning.
3108 Cellphone service providers should also be able to describe mobile assets and restoration planning which
3109 planners can leverage across all emergency planning, not just in nuclear detonation plans. **Damage to**
3110 **electronic communications equipment by the EMP will not be permanent outside of SDZ.**

3111 EMPs have the potential to damage electronic equipment near the detonation.

3112 **Most electronic equipment will be operable after a reset.** Fatal damage to electronic equipment will be
3113 mostly contained within the SDZ, where blast effects will physically damage electronic equipment beyond
3114 repair. Electronic equipment outside of the SDZ may be operable after a reboot or restart.

3115 **Infrastructure damage will be more widespread than EMP damage, and residents should be encouraged to**
3116 **download just-in-time information on their phones or tablets before an incident occurs.** Infrastructure
3117 damage may disable communication electronics. Power and phone lines will probably be damaged,
3118 preventing cellphones from connecting even if they are functional.

3119 For more information regarding EMP effects, see Appendix 1.1: EMP, HEMP, and GMD.

3120 **2.2.4. PORTABLE CONNECTIVITY TECHNOLOGY IS CONSTANTLY IMPROVING.**

3121 **Pre-coordinate portable connectivity technology through FEMA and state-level resources to re-establish**
3122 **connectivity in the affected area.** In many emergencies, jurisdictions rely on mobile cell towers to
3123 reestablish connectivity in affected areas. Cell providers use Cell on Wheels/Wings (COWS), Cell on Light
3124 Trucks (COLTS), Cellular Repeater on Wheels (CROW), and Generator on A Trailer (GOAT) to provide this
3125 capability. FEMA's strategic stockpile also contains mobile cell towers for this purpose.



3126 **Coordination Opportunity**

3127 Pre-coordinate portable connectivity resources with FEMA and state-level officials.

3128 **Identify new networks available to ensure incorporation in communication and infrastructure plans.** Follow
3129 updates in communications-restoration technology and incorporate proven methods into planning for
3130 communication restoration following an emergency.

3131 **2.3. Worldwide Media Interest**

3132 A nuclear detonation will attract 24-hour, multi-platform, multi-outlet coverage across the globe. This
3133 interest will be overwhelming for any one jurisdiction. Prior coordination with nearby jurisdictions, state
3134 communications offices, and federal communicators will help public information staff at all levels address
3135 global questions and concerns.



3136 **Action Item**

3137 Coordinate with nearby jurisdictions in advance, to ensure public information staff have
3138 necessary assistance.

3139 **2.3.1. NEWS OUTLETS AND MEDIA PUBLICATIONS CAN BROADLY DISSEMINATE SAFETY** 3140 **MESSAGES AND COMBAT RUMORS AND MISINFORMATION.**

3141 **Coordinate with and educate media outlets before, during, and after an incident, to effectively coordinate**
3142 **messages throughout the entire impacted area.** Advanced knowledge will ensure the media reinforces
3143 protective action messages. During the first operational response periods, your message to the public and
3144 the press must remain clear, concise, and consistent. Focus messaging on what the public can do to
3145 protect themselves.

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Coordination Opportunity

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Coordinate with media outlets prior to incidents to ensure effective and consistent messaging during response.

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2.3.2. PREPARE A STRATEGY TO PRIORITIZE REQUESTS AND CATALOG APPROVED ANSWERS TO PRESS AND PUBLIC QUESTIONS, AND EXERCISE THIS REGULARLY.

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Anticipate communications staff being overwhelmed and establish priorities to keep limited communications staff focused. Your typical PIO staff will be immediately overwhelmed by requests for information, press inquiries, and public inquiries. Prioritizing information needs will be critical to the response's efficacy.

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Create a bank of approved message to answer common and repeated questions. Approve responses for the press and public, and catalog the questions received and answers sent. Reusing responses increases timeliness of delivery.

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Action Item

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Prioritizing information requests from responders, the press, and the public is critical and should be practiced and exercised regularly.

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Store approved messages for easy access across jurisdictions. Identifying appropriate cataloging methods for approved messages can be a challenge. Whether you choose a shared document, a database, or other method, the entire public affairs team and anyone staffing a public affairs position must have access. Establishing a message sharing strategy before an incident happens, exercising it, and troubleshooting challenges are recommended.

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Depending on the command structure, you may want to give access to people outside of your organization. Whether you use a system that can allow for outside access or note that it may be a technological problem, make sure to address it in your plan.

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2.4. Intraorganizational Communication Challenges

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To sustain response, your organization must emphasize information sharing, prioritize your staff's needs, and ensure staff have the time and space to take care of their loved ones. Because every moment of work matters, effective internal communications are as important as external communications to response efforts.

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2.4.1. PROTECTIVE ACTIONS AND SITUATIONAL AWARENESS MUST BE COORDINATED BEYOND YOUR ICS STRUCTURE.

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Well-informed staff can serve as official information ambassadors and broadcast reliable information to their loved ones and networks. As with other responders, communications staff can be a trusted source of

3178 information in their communities and networks. Their relationships with friends, family members, and loved
3179 ones can be leveraged to disseminate accurate and actionable information, and combat rumors and
3180 misinformation.



Action Item

3181

3182 Keep staff well informed to both serve as conduits for official information, and to provide a critical
3183 sense of control during the response.

3184 **Internal communications should include routine information balanced with critical messaging.** An internal
3185 crisis communications plan should be part of your overarching communications strategy. In addition to
3186 acknowledging concerns about your staff's friends, family members, and responding coworkers, there will
3187 also be long-term logistical questions about payroll and health care. Remaining mindful of staff needs will
3188 increase trust and help your jurisdiction prepare for a long response and recovery process.

3189 **Leverage existing information sharing structures throughout organizations.** Organization-wide email
3190 listservs, mass notification systems, and even verbal updates give staff a chance to ask questions and
3191 provides an outlet for their concerns and questions. Providing response information will mitigate some of
3192 the anxiety and distress that will be present due to the scale of this incident.



Coordination Opportunity

3193

3194 Incorporate pre-existing sharing networks, like listservs and mass notification systems, into response
3195 plans.

3196 **Involve communications staff in critical decision making to maintain a COP that informs consistent**
3197 **messaging.** Planners must consider how the communications team will remain aware of the overall COP to
3198 ensure messages are drafted and released when they are most effective. If communications staff are not
3199 involved in critical discussions as decisions are made, they will struggle to keep messaging current,
3200 especially in the first days of a nuclear detonation incident.



Coordination Opportunity

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3202 Incorporate communications staff in all areas of the response to identify response priorities, increase
3203 message consistency, and gain insight on potential public message issues.

3204 2.5. Loss of Life Messaging

3205 A nuclear detonation will be one of the highest mass-casualty incidents in U.S. history. Death tolls will range
3206 from tens to hundreds of thousands, and people will sustain injuries for miles surrounding the detonation
3207 site. Ultimately, there are some bodies that responders will never be able to recover. **Whether you are out in**

3208 **the field, planning for mobile morgues or writing fatality messages, dealing with the sheer magnitude of**
3209 **fatalities will be amongst the more harrowing aspects of a nuclear detonation response.**

3210 **2.5.1. DISCUSSING DEATH TOLL AND CASUALTY COUNTS WILL BE AN ONGOING CHALLENGE**
3211 **AND MUST BE TREATED WITH CARE AND RESPECT.**

3212 **Prepare to release messages with the best information possible, which may not be complete or exact.**
3213 Questions about the total number of people lost and the total number of people injured will be constant.
3214 There is no perfect way to acknowledge and answer these questions. Pain, loss, and grief will always be
3215 attached to this incident, and no matter what, your response community will likely never have a firm count
3216 of the number of people who died and the number of people who were injured. Acknowledging this
3217 uncertainty is critical when preparing such messages.

3218 There is little advice on how exactly to do this, there is no template to follow, there is simply the need to do
3219 it; lean into the feelings of the impossibility of the situation, and write with compassion, vulnerability, and
3220 strength. Staff should know that there is no right answer to this question—they should use what they would
3221 want to hear as a starting point, and work from there. Ultimately, your message will help your community
3222 begin the recovery process and provide a sliver of closure and comfort to people who have lost a great
3223 deal.

3224 **Determine the most effective spokesperson to deliver messages about the death toll in your community.**
3225 Communicating respect and care in your answers to these questions will be crucial for public trust.
3226 Acknowledging the loss of thousands of people must be carefully expressed and should come from a
3227 trusted member of response efforts—likely a trusted member of the affected community. It is ok to
3228 acknowledge the uncertainty surrounding the number of people lost but it must be coupled with care for
3229 and commitment to the loved ones of those who died. This will increase the public’s confidence that fatality
3230 management is being handled with the utmost care and respect. Never speculate on the conditions or
3231 numbers of people who have been recovered from the scene, simply stick to the facts of what response
3232 can confirm. (EPA, 2007)

3233 **Plan to enlist the assistance of professionals who routinely communicate about death and grief.** There are
3234 professions such as medical examiners and funeral directors who deal daily with death and
3235 communicating with people affected by it. While they will likely not have considered the large scale of this
3236 incident, they can offer support in a sensitive and emotionally charged situation.

3237 **2.5.2. RECOGNIZE AND RESPECT THE EMOTIONS OF THE RESPONDERS TASKED WITH**
3238 **FATALITY-RELATED WORK.**

3239 **Fatality management and body recovery will be a constant reminder of how many people were lost.**
3240 Throughout the recovery phase, responders, recovery workers, and special teams will continue to recover
3241 bodies from the affected area. This will be an ongoing source of extreme stress for emergency responders
3242 and recovery workers. Your communications team must take special care in responding to questions about
3243 the health of responders in order to keep a high-level of trust between organizations and your
3244 communications team. Do not diminish the effects of the response on your responders. Communicate with
3245 first response organizations’ management about how they would like to address the mental health of all
3246 responders.

3247 **Work closely with mental health professionals to meet the needs of your staff.** It should be noted that, if
3248 you are not a licensed mental health practitioner, you are not qualified to make diagnostic judgements
3249 about the mental health status of your staff. Plan to work with local mental health practitioners to help
3250 support staff. In the absence of a dedicated mental health team, the deployed ICS Safety Officer should be
3251 tasked with observing staff for mental health. Working closely with the jurisdiction's mental health services
3252 and providers will be important.

3253 **Chapter 7: Alerts, Warnings,**
3254 **Notifications, and FEMA’s Integrated**
3255 **Public Alert and Warning System**
3256 **(IPAWS)**

3257 **1. Importance of Public Alerts, Warnings and Notifications**
3258 **(AWN)**

3259 In any emergency, adequate preparation, timely alerts, and actionable warnings assist residents of an
3260 affected community by providing critical safety messages to protect them. In the immediate aftermath of a
3261 nuclear detonation, instantaneous AWN is necessary to tell people in the affected area how to avoid death
3262 and injury from radiation. Development of significantly improved AWN capabilities, such as FEMA’s IPAWS,
3263 is helping to mitigate hazards and lessen the impact of all disasters, including nuclear detonation. Planners
3264 have a critical role to ensure AWN guidance and procedures are documented so they can be applied,
3265 tested, and exercised. Awareness of the importance of AWN planning guidance related to nuclear
3266 detonation needs to be increased by prominently incorporating the key planning factors in this chapter into
3267 all plans, procedures, SOPs, and checklists related to nuclear detonation response.

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- 3269 ▪ An **alert** urgently informs recipients that something significant has happened or may happen. The
3270 distinction between alerts and warnings is not always clear-cut because a warning can also serve
as an alert, and an alert may include some additional information, such as protective measures.
 - 3271 ▪ A **warning**, which typically follows an alert, provides more detailed information, indicating who is at
3272 risk, where the risk resides, who is sending the warning message, and what protective actions
3273 need to be taken. The issuance of an all-clear message is sometimes considered to be the final
3274 stage of the alert and warning (A&W) process.
 - 3275 ▪ A **notification** is a message informing an entity or individual of a situation. Notifications may occur
3276 during the plan development process or at any time throughout the life cycle of an incident, event,
3277 or threat. Examples of notifications in FEMA are activation orders, mission assignments, team
3278 deployments, or informing state and local officials and the public of natural disasters, terrorism, or
3279 attacks.



3280 **Action Item**

3281 Planners must document, apply, test, and exercise AWN guidance for nuclear detonation incidents.

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Coordination Opportunity

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Planners must lead intergovernmental coordination of response communication plans, including FSLTT communications.

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All disasters are local. As first responders are gearing up to respond to the initial effects of an incident, it is the responsibility of local officials having public alerting authority to rapidly and effectively communicate public actions to protect lives and property. This is especially important in a nuclear detonation situation having little or no advanced warning when the federal response has not been activated. The widespread availability of public AWN capabilities is a critical element of FEMA's hazard and incident public communications efforts.

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Operational AWN planning is vital for the nuclear detonation situation. A dead zone of destroyed electrical grid, cell towers and internet outages will exist post-detonation. Anxiety about hazardous radiation will strongly affect the public, who will seek guidance on protective actions. The 2018 false missile alert in Hawaii showed the sensitivity of public messaging associated with a nuclear threat.

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The adverse effects of a nuclear detonation on the means for public AWN makes it especially important for planners to proactively take them into account during the preparedness phase.⁴² This new chapter has been added to include guidance regarding a possibility or likelihood of some advanced warning of an incoming missile and nuclear detonation, in addition to post-detonation scenarios that require functioning AWN capabilities to sustain public messaging, especially in the immediate aftermath.

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The National Emergency Communications Plan (NECP) lists AWN among the four basic emergency communications functions. The purpose of AWN in the NECP is:

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“Instructional messages directing protective actions to save lives and property, and convey time-sensitive information for preparation, response, and recovery-related services.”

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Refer To

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NECP has guidance for the entire emergency communications ecosystem and specifies AWN functions, including incorporating diverse AWN technologies and interoperability:

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https://www.dhs.gov/xlibrary/assets/national_emergency_communications_plan.pdf

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Planners are responsible for following guidance to ensure AWN tools can perform basic functions pre- and post-detonation. The “Get Inside, Stay Inside, and Stay Tuned” message works for both pre- and post-detonation. Continuing to send this message can be expected to prevent thousands of casualties from

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⁴² This AWN guidance can also be considered regarding other releases of radioactive material that put the public at risk.

3311 fallout exposure in large urban areas if provided in the first few hours (the earlier the better). Pre-
3312 detonation messaging can help prevent fallout exposure and reduce initial effect casualties.



Action Item

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3314 Ensure all post-detonation AWN messaging includes “Get Inside, Stay Inside, Stay Tuned.”

3315 Other types of incidents require extremely rapid pre- or post-event shelter-in-place or evacuation orders,
3316 such as earthquakes, tsunamis, NPP emergencies, wildfires, flash floods or dam breaches, and hazardous
3317 material spills. The use of AWN guidance in this chapter is not limited to planning for a nuclear detonation.

3318 In this regard, Mileti & Sorenson’s “A Guide to Public Alerts and Warnings for Dam and Levee
3319 Emergencies” is particularly important and useful reference for nuclear detonation planners. (US Army
3320 Corps of Engineers, 2019)



Coordination Opportunity

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3322 Coordinate with IPAWS Program Management Officer (PMO) and other relevant authorities to enable
3323 PAWs capabilities.

3324 Information and guidance about public AWN are important because details about methods, timing, and
3325 other AWN factors are critical. For example, both planners and responders need to know the differences
3326 between mass notification using alert origination tools (AOTs), and the IPAWS platform that enables
3327 simultaneous dissemination of AWN by several channels using advanced communications interoperability
3328 technology. A careful review of recent media reports shows understanding the difference is paramount to
3329 saving lives when seconds matter.



Coordination Opportunity

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3331 Coordinate with other state and local authorities in your area, such as emergency management
3332 agencies, fire and police stations, military bases, universities, hospitals, and NPPs.



Refer To

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3334 *The Community Lifelines Toolkit* explains the seven different lifelines and their subcomponents,
3335 highlighting key infrastructure to consider during emergency response.

3336 <https://www.fema.gov/sites/default/files/2020-05/CommunityLifelinesToolkit2.0v2.pdf>

3337 2. Public Alerting Authorities

3338 The ICS provides a standardized approach to incident management that enables efficient functional
3339 integration into an effective response organization. Because public AWN is an essential element for
3340 meeting emergency information needs, it is an important factor in the ICS. Issuance of authoritative public
3341 AWN is among the key staff functions of an EOC, according to the Response Federal Interagency
3342 Operational Plan (FIOP). In discussing delivery of the Operational Coordination Core Capability, the FIOP
3343 describes SLTT, and insular area governments as “functioning and operating from their designated
3344 emergency operations centers.” These EOCs receive guidance from elected or appointed officials at all
3345 levels who have authority and responsibility to decide many issues including public AWN. Insufficient
3346 attention to AWN in an EOC is risky.



3347 Refer To

3348 ICS is a command framework for incident response:

3349 https://www.fema.gov/sites/default/files/2020-07/fema_nims_doctrine-2017.pdf

3350 **A jurisdiction’s EOC is typically designated as the official alerting authority under the emergency manager**
3351 **or higher authority to issue public AWN.** Designated EOC staff who are authorized to operate AOT software
3352 receive special training. Issuing public AWN is a challenge, partly because there is not always timely
3353 feedback on public responses. Public AWNs must be issued on time, by credible sources, to persuade the
3354 public to act and follow instructions; save lives; and protect property.



3355 Coordination Opportunity

3356 To carry out their AWN mission, EOCs must coordinate effectively with a variety of guiding authorities
3357 during emergencies.

3358 There are nearly 6,000 state and local EOC public alert initiators, and the AWN ecosystem continues to
3359 grow (U.S. Department of Homeland Security, 2021). Nearly 1,600 IPAWS alerting authorities are active
3360 nationwide and in U.S. territories and their rate of increase is growing.

3361 By Federal Communications Commission (FCC) regulation, only IPAWS alerting authorities are capable
3362 of sending WEA to commercial mobile devices without subscription.

3363 Public alerting authorities need to draw on Annex N of the ESF-15 SOP in developing and exercising short,
3364 pre-scripted messages in addition to “Get Inside, Stay Inside, Stay Tuned.” They must be prepared to very
3365 quickly send alerts before a nuclear detonation, and in the immediate aftermath. Surviving alerting
3366 authorities must also be prepared to continue public messaging of fallout and other hazards as described
3367 in Chapter 6 and elsewhere in this guidance.

3368



Refer To

3369

ESF-15 is the external affairs annex to the FIOPs: https://www.fema.gov/sites/default/files/2020-07/fema_ESF_15_External-Affairs.pdf

3370

3371 Planners of response to a nuclear detonation, particularly in urban areas, must endeavor to ensure a
3372 minimum essential non-subscription WEA capability can survive to provide immediate public AWN after a
3373 nuclear detonation. Although the internet is required to send a WEA, recent discussions with technical
3374 experts have indicated that it is prudent to send an alert and not assume that the internet is down across
3375 the entire country. WEAs are described in more detail below.

3376



Action Item

3377

Include WEA capabilities in AWN plans.

3378 Subscription versus non-subscription public AWN for mobile devices is a complicated topic (Bean, 2019).
3379 After a nuclear detonation, there is no alternative to near-immediate public AWN for fallout warning and
3380 orders to shelter in place to save potentially thousands from the most dangerous initial radiation exposure.

3381 Annex C of the Response FIOP also describes the roles and functions of JICs in coordinating public
3382 messaging. It also explains that the Secretary of Homeland Security may appoint ESF-15 deputies to
3383 affected states and regions to bolster coordination.

3384



Action Item

3385 Identify the number of IPAWs alerting authorities needed in your urban planning area that could enable
3386 a post-detonation WEA alerting capability to remain operational in the immediate aftermath.

3387 The foregoing points are included to highlight for planners the critical importance of maintaining some
3388 minimum essential means for originating AWN through multiple dissemination channels to sustain the ESF-
3389 15 mission in operation, without interruption in the immediate aftermath of a nuclear detonation. This
3390 requirement for resilient AWN capabilities includes both state and local JICs. **Careful and comprehensive**
3391 **advanced planning is necessary to meet critical public AWN needs.**

3. Public A&W Systems for Mass Notification

3393 This section describes in general the types of AWN systems in use because planners need to know the
3394 types and locations of all available alert dissemination channels in order to be able to use those outside
3395 the nuclear detonation damage zones immediately, pre- and post-detonation.

3396 Senior leader decisions and other messaging frequently needs to be rapidly communicated to the public
3397 via AOT. AOT refers to software used in EOCs to issue public AWN.

3398 **3.1. Local Jurisdiction Emergency Notification Systems.**

3399 The characteristic types of mass notifications include text messages, social media, e-mails, and reverse dial-
3400 back systems. The latter can be based on public databases, subscriptions, or both. These systems have
3401 varying degrees of capability for multiple languages, media types, and special features. AOTs generate the
3402 following kinds of mass notifications:

3403 **Opt-in/Sign-Up**

3404 **Text and Email Systems.** Many jurisdictions have opt-in public AWN systems. An opt-in system means
3405 individuals must sign up to receive AWN. Once they have signed up, officials in their area can deliver text or
3406 email messages about local emergencies.

3407 **Enhanced Telephone Notification Systems (ETN).** In the event of an emergency, local officials in many
3408 communities can send AWN to individuals in an at-risk area using an ETN system. Most ETN systems push
3409 AWN to banks of landline phone numbers. Some ETN systems also allow messaging on Voice over Internet
3410 Protocol (VoIP) and mobile phones through an opt-in arrangement.

3411 **Outdoor Sirens and/or Voice Alert Systems.** Outdoor sirens and/or voice alert systems are used to alert
3412 people of an immediate danger so they can take cover, such as those near an NPP.

3413  **What Would You Do?**

3414 If you have a siren system, how often is it tested? What factors should be considered to determine a
3415 siren's resiliency in a nuclear detonation scenario?

3416 **Local School or Organization Notification Systems.** Many workplaces, schools, and community
3417 organizations have systems that provide alert and warning along with tailored notifications. These may
3418 range from automatic parent contact distributions by phone or email, to email distribution lists that enable
3419 individuals to opt-in for text and email systems.

3420 **3.2. Effects of Delays in Alerts, Warnings and Notifications**

3421 Pre-incident alert and warning preparedness planning needs to be informed by keen awareness of the
3422 existence of delays in the issuance of alerts, and that the effect of such delays is additive (Figure 33).
3423 This awareness is needed throughout the ICS, and particularly among EOC supervisors and staff
3424 members. Readiness training of individuals who are Alert Originators⁴³ needs to promote this
3425 awareness. Delays, and their additive effects, need to be removed or mitigated wherever possible.
3426 Results of tests, training and exercises need to be tracked and applied toward certification,
3427 specialization, or qualification for a position such as Public Warning Specialist or a similar position of
3428 AWN subject matter expertise.

⁴³ This phrase usually refers to the person operating an alert origination tool that sends an AWN.



3429

3430

Figure 33: Effects of Delays in Alerts and Warnings (derived from Mileti, 2019).

3431 Timely responses are important for all AWN and are especially urgent in nuclear detonation scenarios.

3432 Many planners have received recommendations to prepare pre-scripted messages and to have them saved
 3433 to their desktops. Caution is needed because on occasion, the AOT software or dissemination platform
 3434 requires sending the message within prescribed times (i.e., within a certain number of minutes) after the
 3435 alert has been prepared.

3436 4. Integrated Public Alert and Warning System (IPAWS) 3437 Components

3438 4.1. Introduction to IPAWS

3439 The IPAWS is a national A&W infrastructure available for use by FSLTT public alerting authorities to send
 3440 emergency alerts to citizens. The Integrated Public Alert and Warning System Open Platform for Emergency
 3441 Networks (IPAWS-OPEN) receives and authenticates messages transmitted by alerting authorities. IPAWS-
 3442 OPEN then routes the messages to IPAWS communications pathways. IPAWS-OPEN transitioned to cloud
 3443 provider facilities in April 2021. The IPAWS PMO works to provide alerting authorities with the advanced
 3444 technologies, capabilities, and resiliency that IPAWS offers. FSLTT alerting authorities may choose to
 3445 integrate local AWN systems that use Common Alerting Protocol (CAP)⁴⁴ standards with the IPAWS
 3446 infrastructure. IPAWS provides public safety officials a gateway to send A&W messages to the public using
 3447 the Emergency Alert System (EAS), WEA, National Oceanic and Atmospheric Administration (NOAA) Weather
 3448 Radio All Hazards (NWR), and other public alerting systems, all from a single interface. A memorandum of
 3449 agreement (MOA) with FEMA is required and there are technical requirements for an alert authority to
 3450 connect with IPAWS-OPEN, but no fee. Figure 34 below depicts the IPAWS architecture, including the CAP
 3451 standards-based interoperability that enables dissimilar alert originators to select multiple alert distribution
 3452 channels to meet specific needs.

3453 Executive Order (EO) 13407 signed in June 2006 is the fundamental guidance. PL 114-143, the IPAWS
 3454 Modernization Act of 2015 directed FEMA to:

⁴⁴ CAP is an extensible Markup Language (XML) standard adopted by the International standards-making body, the Organization for the Advancement of Structured Information Systems (OASIS).

- 3455 1. Establish common alerting and warning protocols, standards, terminology, and operating procedures
3456 for the system;
- 3457 2. Include the capability to adapt the distribution and content of communications on the basis of
3458 geographic location, risks, and multiple communication technologies;
- 3459 3. Alert, warn, and provide equivalent information to individuals with disabilities, access, and functional
3460 needs, or limited English proficiency; and
- 3461 4. Ensure that specified training, tests, and exercises for such system are conducted and that the system
3462 is resilient, secure, and can withstand external attacks.
- 3463 These important capabilities are operational and available for planners to incorporate into their urban area
3464 nuclear detonation response plans.



Refer To

3465

3466 E013407 and PL 114- 143 contain basic IPAWS guidance:
3467 <https://www.congress.gov/114/plaws/publ143/PLAW-114publ143.pdf>

3468 The 2020 National Defense Authorization Act, PL 116-92 states that the authority to originate an alert
3469 warning the public of a missile launch directed against a state using the public A&W system shall reside
3470 primarily with the Federal Government. This law includes information sent to State Warning Points (SWPs)
3471 through National Warning System (NAWAS). FEMA has begun work on obtaining funding and recommended
3472 approaches to implement the provisions of PL-116-92.

3473 Implementing the first two laws has enabled FEMA to better coordinate among state authorities and
3474 hundreds of localities based on common protocols and language across jurisdictions. Planners of response
3475 to a nuclear detonation need to know and carefully analyze the locations of all EOCs in their area of focus;
3476 especially the capabilities of their AOTs, including specifically each IPAWS Alerting Authority. The AWN
3477 planning goal must be to sustain the survivability of at least one EOC within the planning area to ensure
3478 public AWN messaging in the immediate aftermath of a nuclear detonation.



Action Item

3479

3480 Create a comprehensive list of each EOCs AWN capabilities and IPAWS alerting authorities in your
3481 urban planning area.

3482 Emergency management and public safety officials should take full advantage of IPAWS' capabilities. IPAWS
3483 alerting authorities are encouraged to regularly conduct more than the minimum required AWN training and
3484 testing; and to seek out opportunities to participate in exercises that include issuing practice alerts. Each
3485 IPAWS Alerting Authority is required, based on its memorandum of agreement with FEMA, to:

3486 "…demonstrate their ability to compose and send a message through the IPAWS-OPEN system at
3487 regular intervals. Such demonstration must be performed on a monthly basis through generation

3488 of a message successfully sent through the IPAWS-OPEN Training and Demonstration
3489 environment.” (FEMA, 2021b)

3490
3491 IPAWS includes two primary components, the IPAWS-OPEN and the National Public Warning System (NPWS)
3492 as shown in Figure 34.

3493 Use of the CAP standards-based interoperability also enables industry partners to develop content and/or
3494 devices that can be used by individuals with disabilities, access needs, and functional needs, to receive
3495 emergency alerts. CAP alerts can transport rich multi-media attachments and links in alert messages. The
3496 IPAWS PMO participates in operational testing and evaluation of products and is continually working toward
3497 integrating additional technologies and encouraging industry or private sector innovation to meet the needs
3498 of the whole community.

3499 Alerting Authorities that fail to demonstrate their proficiency in the IPAWS Lab for three consecutive months
3500 will lose access to the IPAWS Live environment and will not be permitted to send alerts through IPAWS. It is
3501 imperative that public confidence in our A&W systems remain high, and that the information provided to the
3502 public is always clear, authoritative, and trusted.

3503 **4.2. National Public Warning System Component**

3504 EO 13407 provides, among other things, the authority and operational framework for IPAWS along with a
3505 mandate that the EAS is to be administered as a critical component. The Primary Entry Point (PEP) stations
3506 are a key element of the EAS defined by the FCC rules requiring all NPWS, cable television systems,
3507 wireless cable systems, satellite digital audio radio service (SDARS) providers, and direct broadcast
3508 satellite (DBS) providers to receive and immediately re-broadcast a Presidential warning message in the
3509 event of a national emergency. EAS participating radio and television providers nationwide are the stewards
3510 of this important public service in close partnership with alerting officials at all levels of government.⁴⁵
3511 NPWS, also known as the PEP stations, consists of private or commercial radio broadcast stations that
3512 cooperatively participate with FEMA to provide emergency A&W information to the public before, during,
3513 and after incidents and disasters (Figure 34). The FEMA NPWS PEP stations serve as the primary source of
3514 initial broadcast for a national (Presidential) alert, as discussed below, specifically regarding nuclear attack
3515 warning (FEMA, 2016b). NPWS stations are equipped with back-up communications equipment and power
3516 generators designed to enable them to continue broadcasting information to the public during and after an
3517 incident. The IPAWS PMO has expanded the number of participating broadcast stations across the nation
3518 to directly cover more than 90 % of the U.S. population. Secure satellite communications are fully
3519 integrated with NPWS to provide a reliable, redundant communications system that ensures delivery of
3520 national emergency A&W but does not rely on connection to the internet.

⁴⁵ The EAS includes the NPWS PEP stations along with all radio and television broadcasters, cable television, wireless cable systems, SDARS and DBS providers.

3521



Coordination Opportunity

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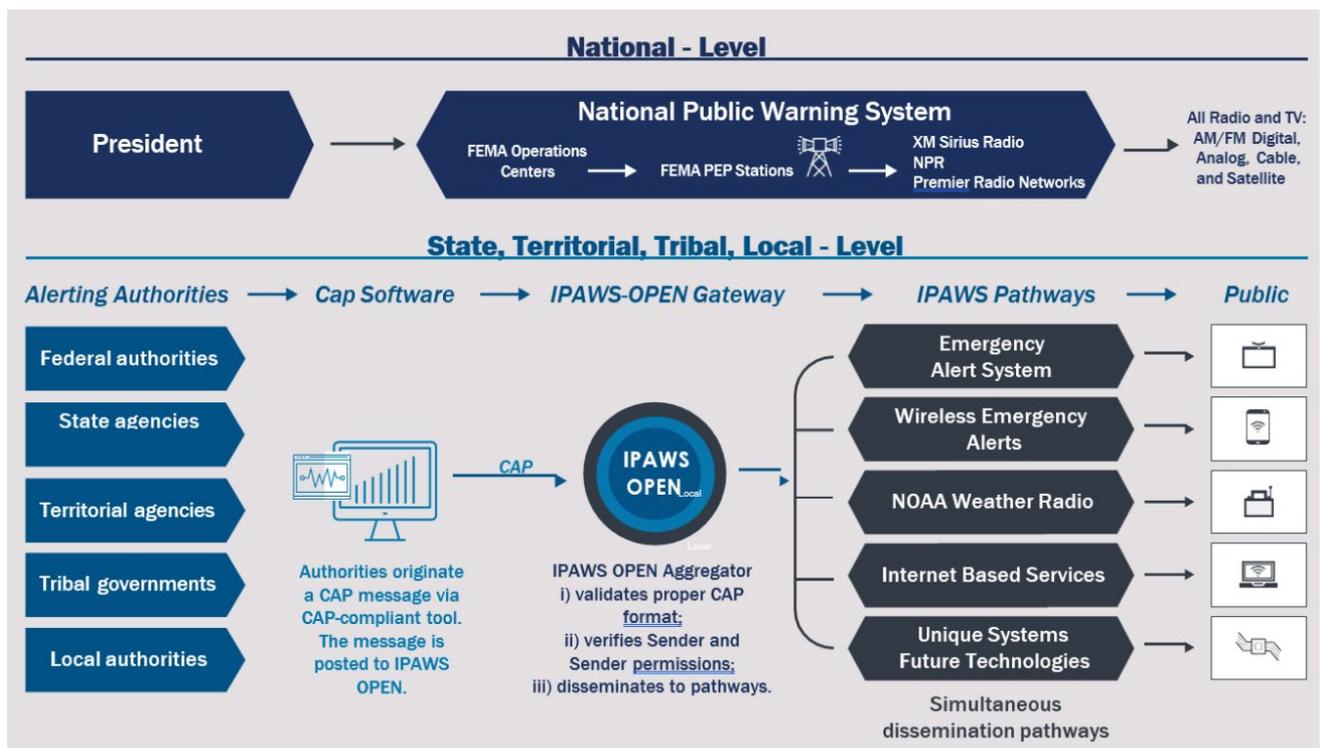
- IPAWS alerting authorities' test verifications are opportunities to collaborate with local broadcasters.

3524
3525

- The NPWS PEP station network exemplifies private and commercial sector coordination with federal entities.

3526
3527

- Leverage mutual aid or assistance agreements, to provide redundancy and resiliency of AWN capabilities following a nuclear detonation.



3528

3529

Figure 34: IPAWS-OPEN and National Public Warning System (NPWS) Architecture.

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3531

4.3. Integrated Public Alert and Warning System Open Platform for Emergency Networks (IPAWS-OPEN Component)

3532

4.3.1. EMERGENCY ALERT SYSTEM (EAS)

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3535
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The EAS is the backbone of national A&W. Due to its resiliency, the EAS is expected to operate when other communication pathways are not in operation. It reaches more people in more places from a single alert origination and can provide highly detailed emergency AWN. EAS is extremely valuable in rural communities and is very important in urban area nuclear detonation and other post-disaster situations. NOAA's NWR, along with SLTT governments use the EAS regularly.

3538 IPAWS-OPEN collects CAP alerts issued by authorized public officials and distributes them to EAS
3539 participants, either over the internet or by over-the-air broadcast. EAS participants are required by the FCC
3540 to monitor both systems for redundancy and, in accordance with state EAS plans, to monitor other
3541 radio/television station sources. EAS participants require an internet connection to poll IPAWS-OPEN.

3542 An audio announcement and text display interrupts programming, including on TVs and radios. Emergency
3543 messages sent via IPAWS to EAS can support full message text for screen crawl/display, audio attachments
3544 such as mp3, and additional languages as determined by local broadcast stations.

3545 Local coordination and partnership are needed because broadcast stations are not required to air local
3546 emergency messages. EAS activation interrupts programming once only. The emergency message audio and
3547 text are repeated twice – then regular program continues. The television display format for EAS varies from
3548 station to station.

3549 Coordination Opportunity

3550 Collaboration with EAS radio stations is necessary to enable local EAS alerting.

3551 Some question the effectiveness of AM/FM radio and satellite radio as channels for disseminating AWN –
3552 particularly in comparison to digital media. Others point out that in 2019 research data from Nielsen and
3553 other sources suggests that radio continues to be an important mode of communications to the public
3554 (Westwood One, 2019). Research data in 2019 showed over 90 % of all Americans reached every week by
3555 radio. Time spent listening (TSL) to AM/FM radio is ten times greater than TSL of streaming platforms and
3556 it reaches 60 % in connected cars. Total AM/FM listeners reached 250 million in 2018. Caution is needed
3557 to avoid exaggeration of access provided by AM/FM radio for purposes of AWN. The devastation and
3558 communications disruptions following a nuclear detonation can reasonably be expected to provide
3559 incentive for greater use of radios in cars and trucks to seek emergency AWN broadcasts.

3560 What Would You Do?

3561 Do you think it is likely that you, personally, would receive an emergency message broadcast on the
3562 radio? How would this vary for different populations in your community?

3563 Planners for urban area response to a low-altitude (~5km above ground level or lower) nuclear detonation
3564 should follow the current technical assessment that “Individual radios outside the moderate damage zone
3565 (at time of detonation) are unlikely to be affected” by SREMP. (LLNL, 2019)

3566 A nuclear detonation will destroy and damage elements of the electrical grid and the communications
3567 infrastructure, which can be expected to result in overload of the communications assets that remain
3568 operational. The *2010 Planning Guidance* stated that “Radio broadcasts may be the most effective means
3569 to reach the people closest to and directly downwind from the nuclear explosion.” Because this observation
3570 remains essentially correct, and gaps in internet connectivity can be expected, planners need to pay

3571 particular attention to the resiliency of EAS, and the potential for AM/FM radio and television surviving the
3572 nuclear detonation, to fill or mitigate gaps in coverage for public AWN.

3573  Action Item

3574 Include battery- powered AM/FM radios in nuclear detonation response plans to leverage radio
3575 availability in cars, trucks, homes, schools, and public buildings.

3576 **This is the “STAY TUNED” part of the quintessential nuclear detonation warning.**

3577 Planners and responders need to consult State Emergency Communications Committees (SECCs) and
3578 Local Emergency Communications Committees who are already responsible for maintaining their FCC-
3579 mandated EAS plan. Planners need to be aware of the need for public alerting authorities to originate a
3580 required weekly test (RWT) message through IPAWS for EAS distribution every week. This will verify their
3581 alerting software is currently able to send emergency AWN through the IPAWS Production or Live system.

3582  Action Item

3583 Ask the IPAWS PMO for PEP station information relevant to your urban area, such as locations,
3584 contact information, and capabilities.

3585 **4.3.2. WIRELESS EMERGENCY ALERTS (WEA)**

3586 WEAs are emergency messages from authorized public IPAWS alerting authorities that can be broadcast
3587 from cell towers to any WEA-enabled mobile device in a locally targeted area.⁴⁶

3588 By federal law and FCC rules, only alerting authorities having an MOU with FEMA and IPAWS-compliant CAP
3589 AOTs (Figure 34) are capable of sending WEAs. Use of the CAP standard-based interoperability also enables
3590 industry partners to develop content and/or devices that can be used by individuals with disabilities,
3591 access needs, and functional needs, to receive WEAs.

3592  Action Item

3593 Ensure your planning area has an MOU with FEMA and IPAWS compliant tools to send WEAs.

3594 The capability to disseminate non-subscription public warning via WEA to all locally geo-targeted mobile
3595 devices to “Get Inside, Stay Inside, Stay Tuned” pre-detonation (if tip-off is provided), during the immediate
3596 aftermath, and continuing during shelter-in-place, evacuation, and fallout plume movements significantly

⁴⁶ Detailed rules for WEA have been published by the FCC in 47 Code of Federal Regulations (CFR) Part 10

3597 improves the odds for survival and damage limitation for the affected population. Thus, planners need a
3598 method to ensure that a minimum essential number of IPAWS alerting authorities remain operating in the
3599 immediate aftermath at EOCs in or near their planning area. This methodology needs to enable a
3600 determination of where to locate additional EOCs with IPAWS alerting authorities could be established for
3601 AWN resiliency in their urban area, and in which EOCs the additional IPAWS alerting authorities should be
3602 located. Planners also need to analyze the effects of cell tower attrition degrading cellphone/mobile device
3603 coverage. They also need to plan ahead to insure resilient alternative transport mechanisms to assure
3604 connectivity for their EOCs in general and for alert originating tools in particular.



Action Item

3605

3606 Identify the number of IPAWS alerting authorities needed in your urban planning area that could enable
3607 a post-nuclear detonation WEA alerting capability to remain operational in the immediate aftermath.

3608 Planners need to leverage IPAWS' advanced AWN interoperability technology by identifying – specifically –
3609 how many IPAWS alerting authorities should be established among EOCs in their planning areas. One very
3610 important goal is to establish, through redundancy of IPAWS-capable EOCs, a posture of at least one EOC
3611 with an IPAWS WEA alerting capability being able to survive the nuclear detonation and remain operational
3612 in the immediate aftermath to broadcast "Get Inside, Stay Inside, Stay Tuned."

3613 IPAWS PMO has released software that supports the following significant FCC-mandated WEA
3614 enhancements:

- 3615 ▪ 360-character alerts
- 3616 ▪ Spanish-language alerts
- 3617 ▪ WEA Test category and Public Safety category
- 3618 ▪ Reach 100 % of the target area with no more than 1/10th mile overshoot

3619 These enhancements also require updates to wireless providers' nationwide networks, customer phones,
3620 and to AOT software that alerting authorities use to send alerts.

3621 The IPAWS PMO has tested and confirmed that wireless providers can receive enhanced WEA messages
3622 from IPAWS-OPEN. But achieving nationwide availability for customers to receive enhanced WEA on their
3623 phones and devices across all cell networks is gradual. Most of the software used by IPAWS alerting
3624 authorities has been upgraded and tested by the IPAWS PMO. It is also a gradual process for all alerting
3625 authorities to become ready to write alerts that fully use all the enhanced WEA message content.

3626



Refer To

3627

IPAWS PMO makes many resources available to help partners and public officials. Downloadable videos and training materials are available at www.fema.gov/ipaws.

3628

3629

WEAs automatically display on the mobile device screen. WEAs can include a URL/web link, enabling recipients to promptly access more detailed information. WEAs use a unique ring tone and vibration, designed to draw attention and alert people to an emergency. The unique vibration, which distinguishes the alert from a regular text message, is particularly helpful to people with hearing disabilities. WEAs in the alert categories of Presidential, America's Missing: Broadcast Emergency Response (AMBER), and Imminent Threat can be sent, in addition to the two new alert categories mentioned above – WEA Test and Public Safety.

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WEAs are targeted to the specific geographic area of the emergency. If a WEA-capable mobile device is physically located in that specific area, it will automatically receive and display the message. WEAs are true location-based alerting because alerts are sent to all phones in a cell tower's coverage area. These alerts are not sent to a database of phone numbers.

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WEAs are not subscription-based. Customers of participating wireless carriers with WEA-capable phones do not sign up to receive the alerts, nor does any app need to be downloaded. No tracking, delivery information nor status feedback is involved with WEAs.

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3643

Customers automatically receive WEAs if one is active in the area where they are located. Wireless customers are not charged for the delivery of WEA messages. Cellphones are delivered opted-in to receive WEAs, but the opt-in setting can be turned off in the settings of individual handset users.

3644

3645

3646

IPAWS' WEAs use SMS-CB, a one-to-many service, that simultaneously delivers messages to multiple recipients in a specified area. By using SMS-CB as the delivery service technology, WEAs avoid mobile device congestion issues experienced by traditional voice and text messaging SMS-PP alerting services. This translates into faster and more comprehensive delivery of messages during times of emergency.

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By federal law and regulation, WEA are received on mobile devices without subscription.

3651

The type of mobile device affects how a recipient sees or receives WEAs. All major U.S. wireless providers are participating in WEA on a voluntary basis. Wireless carriers are selling mobile devices with WEA capability included; however, not all handsets on the market are capable of receiving WEAs. To find out if their mobile device is capable of receiving WEAs, users need to check with their wireless provider.

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A key differentiator of the WEA versus existing subscription-based text messaging alert services is that WEAs enable alerts to be broadcast to any WEA-capable cellphone within range of a targeted cell communications tower, reaching 100% of the target area with no more than 1/10th mile overshoot.

3656

3657

3658 **4.3.3. NOAA NWR**

3659 When complete, National Weather Service’s development of its interface with IPAWS-Open will activate
 3660 IPAWS’ NOAA weather radio distribution pathway shown in Figure 34.

3661 NWR is provided as a public service. It includes more than 1,000 narrow band transmitters dispersed to
 3662 provide coverage throughout all 50 states, adjacent coastal waters, Puerto Rico, the U.S. Virgin Islands,
 3663 and the U.S. Pacific Territories. NWR requires a special radio receiver or scanner capable of picking up the
 3664 signal. Broadcasts are found in the very high frequency (VHF) public service band at these seven
 3665 frequencies (MHz):

3666 **Table 8: Public Service Band Frequencies (MHz)**

| | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|
| 162.400 | 162.425 | 162.450 | 162.475 | 162.500 | 162.525 | 162.550 |
|---------|---------|---------|---------|---------|---------|---------|

3667 This nationwide network owned by the Department of Commerce (DOC)/NOAA broadcasts continuous
 3668 weather information directly from the nearest National Weather Service office. NWR broadcasts official
 3669 Weather Service warnings, watches, forecasts, and other hazard information 24 hours a day, 7 days a week
 3670 to public and private receivers, including institutions such as schools and hospitals that are tuned in for
 3671 continuous of monitoring. The NWR broadcast can wake up radios during the night.

3672 Working with the FCC’s EAS, NOAA also maintains the HazCollect system which is used to broadcast Non-
 3673 Weather Emergency Messages (NWEM) over the same vast nationwide network. In conjunction with
 3674 federal, state, and local emergency managers and other public officials, NWR broadcasts warning and
 3675 post-event information for all types of hazards – including natural (such as earthquakes, tsunamis, or
 3676 avalanches), environmental (such as chemical releases or oil spills), and public safety (such as AMBER
 3677 alerts or 911 Telephone outages). The Response FIOP states:

3678 “During an emergency, NWS forecasters interrupt routine weather programming and send out a special
 3679 tone that activates weather radios in the listening area. Weather radios equipped with a special alarm tone
 3680 feature can sound an alert and give immediate information about a life-threatening situation.”⁴¹

3681 Also, when the NAWAS Attack Warning is received at NWS offices, the warning will be broadcast as an
 3682 NWEM over NWR and NOAA’s Weather Wire Service (FEMA, 2016a).

3683 **4.3.4. IPAWS ALL-HAZARDS INFORMATION FEED TO THE INTERNET**

3684 Internet web services and applications may complete a MOA with FEMA’s IPAWS PMO allowing them to
 3685 access, monitor and retrieve public alerts in CAP format from the IPAWS Public Alerts Feed (Figure 34).
 3686 When organizations and members of the general public then subscribe to the third-party internet web
 3687 services and applications that have MOAs with IPAWS, these subscribers receive public AWN that have
 3688 been issued through IPAWS-OPEN. More than 90 private companies pull the IPAWS Public Alerts feed for
 3689 redistribution of alerts to signage, electronic message boards, smart home systems, speakers, sirens,
 3690 desktops, and mobile applications and substantial growth in the numbers and types of internet connections
 3691 is anticipated. Figure 35 is an example of a smart kiosk that displays WEAs at street level. This kiosk is a
 3692 product of IKE Smart City, an IPAWS All-Hazards Information Feed redistributor.

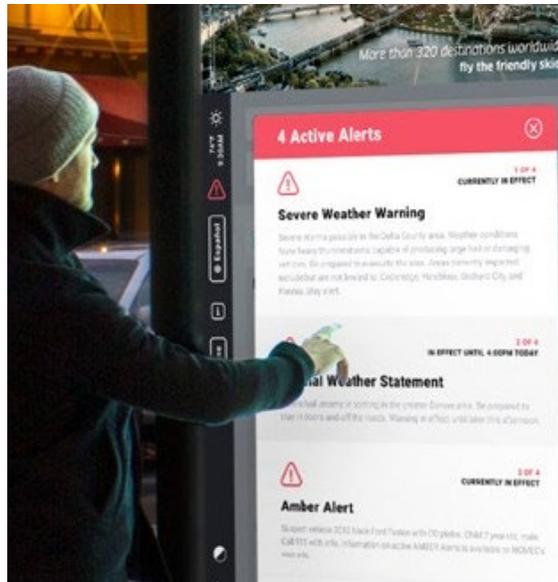


Figure 35: A smart kiosk displaying WEAs.

3693

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3695 Planners responsible for urban area nuclear detonation response need to be aware if this distribution of
3696 all-hazards AWN is occurring among the jurisdictions in their planning area and take it into account in
3697 response planning.



Action Item

3698

3699

Ensure multiple EOCs in your jurisdiction have redundant IPAWS-OPEN connectivity.

3700 4.3.5. COLLABORATIVE DEVELOPMENT WITH IPAWS

3701 Many private vendor companies in the AOT market are working to design IPAWS-compliant alert or ignition
3702 software and other IPAWS-compatible products that can distribute AWN to the public. Such systems include
3703 an IPAWS option or plug-in. As mentioned, much of the infrastructure needed to accomplish the IPAWS
3704 mission is owned and operated by the private sector. More than 20 alert origination software provider
3705 (AOSP) vendor companies have successfully demonstrated their IPAWS capabilities and compatibility – these
3706 numbers are also growing.

3707 AOSPs are developers in both the private and public sectors that furnish software interfaces that alerting
3708 authorities use to generate CAP messages. The software then delivers those messages to IPAWS-OPEN for
3709 dissemination to the public. Private-sector developers' interests vary among different aspects of IPAWS.

3710 More than 130 private sector A&W system non-vendor organizations, plus more than 20 developers of
3711 public sector systems, have executed a MOA with FEMA for the purpose of gaining access to the IPAWS-
3712 OPEN Test Environment. Developers work in various public alerting and other functional categories. FEMA
3713 does not independently verify developer-submitted data. The IPAWS PMO cannot endorse any vendor
3714 products nor tools, but it can provide stakeholders the opportunity to view demonstrations of tools, and to
3715 ask follow-up technical or operational questions.

3716 Planners of nuclear detonation response should monitor ongoing public and private sector IPAWS
3717 programming developments and identify opportunities that can be leveraged to improve AWN distribution
3718 in their jurisdictions.

3719 **4.3.6. BECOMING AN IPAWS ALERTING AUTHORITY**

3720 Any qualifying public safety organization recognized by appropriate FSLTT authorities may apply for
3721 authorization to use IPAWS to send alerts to the public. A prospective alerting authority must have a signed
3722 MOA in place with the IPAWS PMO before receiving access to leverage IPAWS capabilities. Once the MOA
3723 has been approved, a Collaborative Operating Group Identification (COG ID) and digital certificate will be
3724 generated and implemented in the IPAWS-OPEN system. A copy of the executed MOA, along with the COG
3725 ID and digital certificate, will then be provided to the sponsoring organization. A new IPAWS alerting
3726 authority must have a signed MOA with FEMA to enable use of IPAWS. Also, a COG ID and digital certificate
3727 will be implemented in IPAWS-OPEN and provided to the new IPAWS alerting authority along with a copy of
3728 the executed MOA.

3729 For a new IPAWS alerting authority, their COG ID and digital certificate must be implemented in the
3730 IPAWS-OPEN system before use.

3731 Public safety organizations may apply to use IPAWS to exchange alert information with other IPAWS users
3732 with CAP compatible origination software. Each organization that successfully applies to be an IPAWS user
3733 is designated as a COG. When the application steps have been successfully completed the COG will be
3734 granted authority to send alerts to the public through IPAWS and the PMO will issue a certificate for testing
3735 and live operations. It is critical to note that these certificates do have expiration dates and alerting
3736 authorities should work with the PMO to ensure they are up to date. Public safety organizations need to
3737 contact their state's Office of Emergency Management before applying to IPAWS to ensure their state's policy
3738 permits it to act as an alerting authority; every state is different. Some states have rolled out the IPAWS
3739 alerting authority process differently from others, and some have changed their roll out process. When needs
3740 to establish IPAWS alert authorities have been identified by planners responsible for urban area nuclear
3741 detonation response, the planners need to become familiar with the COG roll out process both in their
3742 area and at their state level.

3743  Refer To

3744 Downloadable IPAWS videos and training materials are available at www.fema.gov/ipaws

3745 The IPAWS PMO develops resources for public safety officials that are designed to encourage, assist, and
3746 enable partners to incorporate IPAWS into governance structures, strategies, policies, business models,
3747 and SOPs.

3748 Results of tests, trainings, and exercises needed to be tracked and applied toward certification,
3749 specialization, or qualification for a position such as Public Warning Specialist or a similar position of AWN
3750 subject matter expertise.

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Coordination Opportunity

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The IPAWS PMO collaborates with many private vendors to develop IPAWS compatible AOTs.

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5. Public Alerting, Warning and Notification in Operational Planning

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Previous sections have described common public AWN methods and supporting platforms in use. A

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planning approach shared by many is to use multiple systems and platforms to ensure messages are clear

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and that the source and information content of all AWN public messaging can be trusted. Some of the most

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relevant guidance for pre- and post-detonation planning is the Response FIOP. It and the closely related

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NRIA include very important guidance for the federal interagency and SLTT planners.

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Ensuring that nuclear detonation response plans are informed by this proven guidance will contribute

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substantially to public trust in AWN received during such catastrophic emergency. Additional federal

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guidance specific to AWN from the Community Lifelines' Communications Component, and its important

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relationship to ESF-15, is also discussed.

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Refer To

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The *Response FIOPs* describes how federal agencies coordinate efforts to respond to emergency

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incidents. https://www.fema.gov/sites/default/files/documents/fema_response-fiop.pdf

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5.1. Presidential to Public Alert – Pre-Detonation Scenario

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Warning of an attack would come via a NAWAS announcement from the FEMA Operations Center (FOC)/

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FEMA Alternate Operations Center (FAOC). State-level issuance of WEA would be based receiving a NAWAS

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alert from the FOC/FAOC. This section describes how NAWAS operates pre-detonation and how IPAWS and

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NAWAS operate post-detonation.

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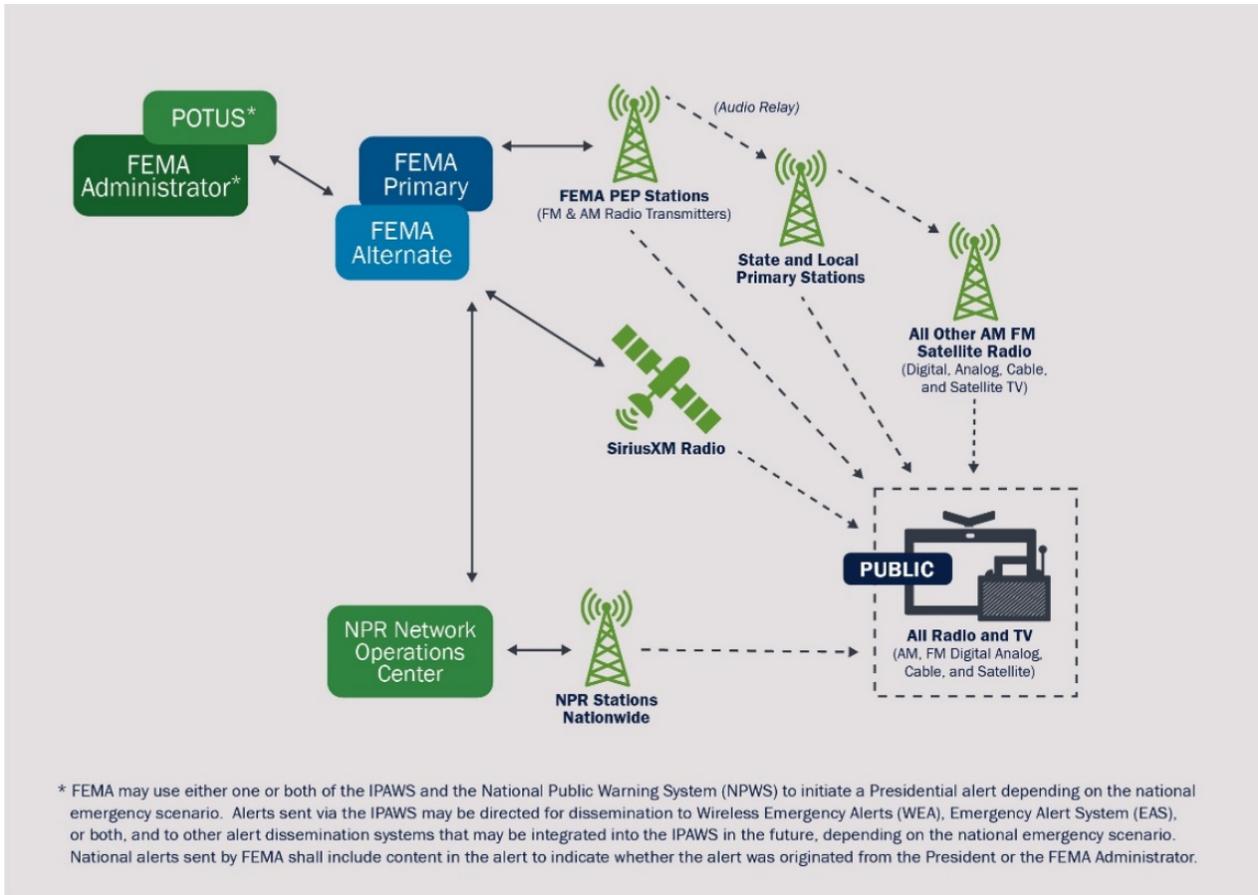
A diagram in the Response FIOP outlines how a national level EAS alert activated by the President reaches

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the public through the channels of FEMA affiliated broadcast stations, SiriusXM satellite radio, and

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National Public Radio; that is, a President to Public Alert (FEMA, 2016b).



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Figure 36: Delivery of Presidential Alert to the Public: Delivery of Presidential Alert to the Public (derived from Response FIOP)

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3778 FEMA may use either one or both of the IPAWS and the NPWS to initiate a Presidential alert depending on
 3779 the national emergency scenario. Alerts sent via the IPAWS may be directed for dissemination to WEA, EAS,
 3780 or both, and to other alert dissemination systems that may be integrated into the IPAWS in the future.
 3781 National alerts sent by FEMA shall include content in the alert to indicate whether the alert was originated
 3782 from the President or the FEMA Administrator.

3783 NAWAS delivers alerts via a continuous private line telephone network. In a pre-detonation scenario, the
 3784 NAWAS Manual specifies that:

3785 “The national-level EAS is activated by an order from the President to the White House
 3786 Communications Agency (WHCA) duty officer or the President’s Communications Officer (PCO)
 3787 through the FOC or FAOC. The FOC/FAOC authenticates the request and establishes the PEP
 3788 conference. At the request of the President, FEMA distributes Presidential Level messages to the
 3789 PEP stations.” (LLNL, 2019)

3790



Refer To

3791

FEMA Manual 211-2-12 is an authoritative reference for FEMA public warning policy, attack alerts, EAS activation, and other alerts. <https://www.hsdl.org/?abstract&did=843365>

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Many response planners are familiar with state and local EAS plans. These plans must be approved by the FCC as the regulatory body since the broadcast stations are privately owned. The FOC/FAOC controls NAWAS priorities, and the SWPs set priorities within their jurisdictions based on non-interference with national priorities. State and local governments routinely use the EAS to transmit critical information to the public, including NWS all hazards' alerts. These localized A&Ws are sent according to state and local EAS plans.

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As mentioned, the *2020 National Defense Authorization Act*, PL 116-92 states that the authority to originate an alert warning the public of a missile launch directed against a State using the public A&W system shall reside primarily with the Federal Government. This law includes information sent to SWP through NAWAS. FEMA has begun work on obtaining funding and recommended approaches to implement the provisions of PL-116-92.

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Subsections below address AWN in relation to the pre- and post-nuclear detonation scenarios being considered throughout this Planning Guidance. The purposes of the following subsections include familiarization with important federal interagency guidance and describing how planners can properly apply the latest technical information about low-altitude nuclear weapon effects in the nuclear detonation scenarios to AWN requirements. This section ends with a discussion of approaches planners should take to ensure the use of multiple AWN pathways in anticipation of the post-detonation damage to critical infrastructure.

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Refer To

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A Science-Based Tool for Emergency Planning, in the October/November 2018 issue of Lawrence Livermore National Lab's (LLNL's) periodical *Science and Technology Review*:

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3814

<https://str.llnl.gov/2018-10/alai>

3815 **5.2. Response FIOP**

3816

The Response FIOP is a model for building an effective AWN program. Federal guidance specific to AWN exists in the Response FIOP and must not be overlooked.

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Although all disasters happen and are responded to locally, it's important that planners at all levels understand the Response FIOP to ensure your SLTT plans include information that allows emergency managers to prepare for the nuclear detonation scenarios. This knowledge will help you identify the source of national level messages and what to expect as well as help you prepare your own pre-scripted messages that you've thought through and saved in order to send them at a moment's notice, without having second

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3823 thoughts on what needs to be communicated. Regional planning also needs to be seriously considered
3824 since some areas of the country now regard only a regional response to a **black sky** disaster that affects
3825 multiple states and jurisdictions to be the most realistic planning approach.

3826 **Black sky** refers to the wide-spread and cascading infrastructure effects of a catastrophic incident
3827 such as nuclear detonation or similar incident such as grid collapse.

3828 In the Response FIOP, an Operational Coordination core capability annex is included as a means of
3829 supporting proper execution of the other Response core capabilities. This annex includes specific reference
3830 to AWN because it is a cross cutter that supports all the Community Lifelines. AWN is deemed “essential for
3831 providing the public with lifesaving and life-sustaining information prior to, during, and following a
3832 catastrophic incident.”⁴⁷ The Response FIOP is correct to emphasize that timely restoration of
3833 communications infrastructure is very important. However, it can be argued that advance identification and
3834 implementation of measures to sustain the operational capabilities of alert origination authorities found
3835 ought to be very high priorities for planners, considering the unique effects of a nuclear detonation.



Action Item

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3837 Nuclear detonation response planning for AWN must be multi-jurisdictional.

3838 Indeed, the Response FIOP continues:

3839 “Careful attention must be paid to survivability of the means to disseminate lifesaving messages
3840 required to protect survivors immediately following a nuclear detonation; or in advance provided
3841 adequate means of technical warning are employed.”⁴⁸

3842 Urban area planners need to develop a methodology for determining where and how many alerting
3843 authorities are needed to sustain continuity and survivability of public AWN from nuclear detonation blast
3844 and other effects. This could include establishing additional IPAWS alerting authorities, enough to prevent
3845 (or strongly mitigate) loss of AWN capability (i.e., WEA and EAS).

3846 Planners of response to a nuclear detonation should know and consider the locations of all EOCs and the
3847 capabilities of their AWN tools, including specifically each IPAWS alerting authority.

⁴⁷ Response FIOP, Annex C

⁴⁸ Response FIOP, Annex C, Appendix 1, “Communications Resources”

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What Would You Do?

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How can online sources in your planning area be collated to provide quick lookups of all EOCs and their AWN AOTs?

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Plans and procedures are needed for alerting authorities in all EOCs in the urban area to rapidly regain situational awareness of others' operating status post-detonation.

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IPAWS PMO is responsible for implementation of most of the provisions of the December 2019 PL 116-92 (National Defense Authorization Act for Fiscal Year 2020, 2020). PL 116-92 requires, among other things, credentialing of all persons who originate alerts, establishing capabilities for immediate cancellation of sent alerts, and other provisions to improve operation of AOTs and alerting authorities in EOCs for more effective public AWN while avoiding mistakes.

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Making specific reference to WEA, the Response FIOP notes the interface to mobile service providers that delivers AWN to "individual mobile devices located within the affected area" and calls out the "geographically targeted, text-like alerts to the public."⁴⁹

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Action Item

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- Ensure AWN provisions in nuclear detonation plans comply with FIOPs.
- AWN plans must identify multiple messaging outlets, to ensure resiliency and redundancy.
- Methodically determine how many alerting authorities are needed at each EOC to prevent loss of IPAWS capabilities.

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The same approach – redundancy and resiliency – is guidance for FSLTT planning efforts to ensure the ability of broadcast radio stations in the urban area to extend their signals to surviving receivers in damaged or denied areas. Examples are car and truck radios, and many organizations such as hospitals, nursing homes, and other businesses that constantly monitor for alerts using NOAA emergency weather radios.

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Action Item

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Ensure pre- and post-incident AWN templates are available for alerting authorities.

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For a nearby jurisdiction to provide AWN capabilities, to substitute damaged or destroyed capabilities, AWN must be included in their Emergency Management Assistance Compact (EMAC), or some comparable agreement. In addition, plans are needed for alerting authorities in EOCs in the urban area to regain

⁴⁹ Response FIOP, Annex C

3876 situational awareness of operating status among area AWN entities. Guidance for situational awareness in
3877 the Response FIOF needs to be applied. Many technical variables need to be considered in a more rigorous
3878 analytical framework.



Action Item

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3880 Plans should include methods for EOCs/alerting authorities to attain information about surviving AWN
3881 capabilities post- detonation.

3882 5.3. Nuclear/Radiological Incident Annex (NRIA)

3883 The NRIA to the Response and Recovery FIOF is also guidance for federal agency planning and a reference
3884 for state and local planners. It includes a public preparedness planning assumption applicable to a nuclear
3885 detonation in an urban area. This planning assumption makes explicit the need for survivable AWN
3886 capabilities pre- and post-detonation:

3887 “Public education on protective actions and response activities prior to an IND attack and prompt
3888 messaging after an attack occurs will minimize the unnecessary loss of life. Failure to inform the public
3889 immediately after an attack will result in the unnecessary loss of life. Public messaging issued by local
3890 authorities immediately after the incident, instructing shelter in place for 12 to 24 hours and “Get Inside,
3891 Stay Inside, Stay Tuned” will be essential to saving and sustaining lives.”⁵⁰



Refer To

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3893 The *NRIA* provides specific federal guidance for nuclear detonation planning.
3894 https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf

3895 The alert origination tools needed to deliver immediate lifesaving messaging are owned and operated
3896 by the states and localities. Planners need to consider approaches to ensure survivable AWN capabilities
3897 at the state and local levels.

3898 The need to plan and implement, in advance, approaches to ensure survivable AWN capabilities, can be
3899 met most effectively at the SLTT levels. Table 9 summarizes critical AWN considerations for planning, from
3900 the NRIA.⁵¹

⁵⁰ *NRIA*, Branch 1, page B1-25.

⁵¹ *NRIA*, Branch 1 IND, Critical Considerations, page B1-7.

3901 **Table 9: Critical AWN Considerations for Nuclear Detonation Preparedness**

| Critical AWN Consideration | Significance in Urban Area Nuclear Detonation |
|-----------------------------------|--|
| Immediate Public Information | Survivable AWN capabilities needed to provide SA & protective actions. |
| Shelter-In-Place Messaging | In the first 60 minutes, most lives will be saved through messaging. |
| Situational Awareness | Enables avoid/mitigate initial & delayed radiation effects & other impacts. |
| SREMP | Grid lines will conduct damaging electric pulse outside blast area. Rapid decline post detonation. |
| Devasted Infrastructure | Survivable messaging needed to reach battery-operated radios inside damage zones. |
| Simultaneous Mission Requirements | Need to maintain survivable dedicated emergency communications channels for AWNs. |
| Secondary Device Threats | Reinforces need for survivable AWNs. |

3902 Another key consideration regarding AWN prior to a nuclear detonation is the requirement to warn
 3903 healthcare and other critical infrastructure sectors, to disconnect from the electrical power grid and go on
 3904 generators or other alternate electrical sources. See the below discussion of the pre-detonation scenario.

3905 Planners need to be aware of significant healthcare related AWN capabilities that advance pre-detonation
 3906 warning would enable to be leveraged. These include the CDC Health Alert Network (HAN), the HHS
 3907 Technical Resources Assistance Center and Information Exchange (TRACIE), and state health department
 3908 alert networks that are networked with CDC’s HAN. The CDC's HAN is a 'push' notification, and the HHS'
 3909 TRACIE is an accessible resource.

3910 TRACIE is a health care emergency preparedness information gateway that ensures all stakeholders at the
 3911 FSLTT government levels; in NGOs; and in the private sector have access to information and resources to
 3912 improve preparedness, response, recovery, and mitigation efforts. The CDC office of the Assistant
 3913 Secretary for Preparedness and Response uses TRACIE to support timely access to information and
 3914 promising practices, identify and remedy knowledge gaps, and to provide users with responses to a range
 3915 of requests for technical assistance.

3916 **6. Community Lifelines and Emergency Support Functions**
 3917 **(ESFs)**

3918 Public AWN is an essential element of information under the Communications Component of Community
 3919 Lifelines in the NRF. Public AWN is a cross-cutting Core Capability, a key element in decision-making, and a
 3920 critical enabler for messaging fallout zones, evacuation orders, and shelter-in-place.

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Refer To

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NRF and NIMS contain overarching FEMA policy for all levels of response.

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- <https://www.fema.gov/emergency-managers/national-preparedness/frameworks/response>

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- <https://www.fema.gov/emergency-managers/nims>

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Action Item

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Ensure plans include consistent alert origination tests and exercises.

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Planners need to mandate increases in the frequency of tests, trainings, and exercises for all individuals allowed to operate AOTs to ensure high levels of proficiency and thereby lessen or eliminate delays and false alerts that detract from public confidence. Planners must also ensure that proficiency in AWN for nuclear detonation scenarios is included in readiness training.

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Sustaining AWN capabilities without interruption post-detonation enables state and local JICs, which become the leading sources of unified public information.

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Refer To

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Annex N - Radiological of FEMA's *ESF-15 SOP* prescribes AWN and other public messaging actions in response to nuclear detonation: https://www.fema.gov/sites/default/files/2020-10/fema_esf-15_sop_2019.pdf

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Action Item

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Training and proficiency validation are critical to ensure rapid AWN delivery.

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Community Lifelines have not replaced ESFs. The availability of IPAWS-OPEN depends on internet connectivity with the planning area hit by a nuclear detonation and what remaining infrastructure and EOC's/alerting authorities remain operational. Community Lifelines communications status reporting includes the electrical power grid, cellphone towers, broadcast towers, mobile communication systems, satellite networks, the internet, other networks, and regional, state, and local partners who have an agreement in place with leadership or EOCs in the area affected by the nuclear detonation.

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Another key federal interagency planning guidance document that explicitly pertains to AWN is the ESF-15 SOP. Among many other significant provisions, Annex N of this SOP emphasizes the critical need to immediately save thousands of lives by avoiding exposure to decay of the most life-threatening radioactive

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3948 fallout. It requires that all messaging must contain "Get Inside, Stay Inside, Stay Tuned" until the fallout
3949 threat picture can be clarified. (DHS, 2019)

3950 **7. AWN Planning Factors for a Low-Altitude Nuclear** 3951 **Detonation**

3952 **7.1. SREMP**

3953 Low-altitude detonations have a significantly smaller area of EMP impact compared to HEMP or GMD
3954 impacts. Low-altitude EMP effects are generally associated with the SREMP and affect a much more
3955 limited area. More information on these effects can be found in Chapter 1 and Appendix 1.1: EMP, SREMP,
3956 HEMP, and GMD.

3957 **7.2. Resiliency Factors**

3958 The most important resiliency element is back-up power. There will likely be regional power outages after a
3959 nuclear detonation. Although actual damage to power systems and their substations will likely be within 12
3960 miles of the detonation, the power grid may destabilize and cause regional power outages. However, like
3961 many other natural disasters that cause power outages, the power systems will likely begin to restore
3962 power within minutes or hours in outlying, undamaged areas.

3963 Resiliency measures for this issue would be backup power (e.g., a generator) for systems that can tolerate
3964 a few minutes of power outage; and an uninterruptible power supply (UPS). The UPS could be either an
3965 online/double-conversion type, or a high-quality line interactive type for systems that can be afforded little
3966 or no down time.

3967 **7.2.1. LEVEL 1: BASIC COST-EFFECTIVE PROTECTIVE MEASURES**

3968 There are several low-cost methods and best practices to greatly improve the likelihood that equipment will
3969 function after the detonation. These measures are appropriate for most systems and improve the
3970 likelihood of continued operation outside of immediate damage areas (greater than 5 miles) is desired.

3971 These measures include:

- 3972 ▪ [When warned] Unplug power, data, and antenna lines from spare equipment where feasible.
- 3973 ▪ [When warned] Turn off equipment that cannot be unplugged and is not actively being used.
- 3974 ▪ Using at least a lightning rated surge protection device (SPD) on power cords, antenna lines, and data
3975 cables; maintain spare SPDs.
- 3976 ▪ Grounding of equipment wherever possible.

3977 **7.2.2. LEVEL 2: ENHANCED ELECTRONIC EQUIPMENT PROTECTION**

3978 To greatly improve the likelihood of continued operation and to protect electronic equipment within 5
3979 miles of the detonation from EMP illumination and line coupled surge, use EMP-capable filters and
3980 surge arresters on power cords, antenna lines, and data cables, as well as installing fiber optics and
3981 ferrites, where possible, to protect critical equipment inside exposed facilities. Within 5 miles significant
3982 blast damage should also be expected and capability survival depends not only EMP protection for
3983 electronics, but also on building integrity. In addition to the level 1 recommendations, consider:

- 3984 ▪ Using EMP-rated SPDs on power cords, antenna lines, and data cables to protect critical equipment.
- 3985 ▪ Using fiber optic cables (with no metal); otherwise use shielded cables, ferrites, and SPDs.

3986 Shielded racks, rooms or facilities may be more cost-effective than hardening numerous cables.
3987 Additional protection may be appropriate for systems expected to operate after a HEMP or GMD
3988 incident, however that is beyond the scope of this guidance.

3989 **8. Planning in Post-Detonation Scenarios**

3990 Post-detonation, the AWN planning goal is to sustain capabilities to continue AWN messaging when key
3991 infrastructure elements have been destroyed or degraded by a nuclear detonation.

3992 According to the NAWAS Manual, North American Aerospace Defense Command (NORAD)/US Northern
3993 Command (USNORTHCOMM) and SWPs are responsible for reporting trans-attack⁵² and post-attack
3994 nuclear detonations to the FOC/FAOC in the form of flash nuclear detonation reports and other types of
3995 extremely urgent reports because locations must be known before responders can begin work. AWN can be
3996 sent to affected areas based on immediate analysis of technical factors (i.e., fallout wind vectors, forecast
3997 plots) described elsewhere in this document. The initial flash nuclear detonation report that states transmit
3998 over NAWAS only include the area hit and the time, unless more details are available immediately. Local-
3999 origin flash nuclear detonation reports need to be sent to the SWP for relay to the FOC/FAOC.

4000 Once a nuclear detonation has occurred, AWN takes on a new mission to continuously provide critical
4001 information to the public through the Recovery phase.

4002 Also, in the post-detonation situation, NAWAS is used by the FOC/FAOC primarily to issue AWN to the SWPs.
4003 They pass the messaging to localities or the public using available communications according to their state
4004 EAS plan, and the AWN distribution channels operational in local EOCs.

⁵² Refers to nuclear detonations from multiple strikes against the U.S.

4005 9. Planning for Use of A&W Pathways

4006 Planners should conduct analyses of their area to identify pre- and post-detonation WEA survivability, other
4007 impacts of attrition on WEA, and to pinpoint EOCs in the affected urban area that need to be IPAWS COGS.

4008 As noted in earlier chapters, the maximum extent of the HZ is the area that could have a dose rate from
4009 radioactive fallout greater than 0.10 R/h and less than 10 R/h. Although this region is outside the DRZ (the
4010 area in which acute radiation effects such as radiation sickness can be expected), it is still an area in which
4011 controls to mitigate exposures should be considered. It is also important to note that the magnitude of the
4012 HZ will initially increase due to fallout deposition and will rapidly (hours to a few days) decrease due to
4013 radioactive decay.

4014 Examples of communications infrastructure that may or may not be impacted include AM and FM
4015 transmission towers; broadband transmitters (radio and educational broadband service); cell towers;
4016 internet service providers; television analog station transmitters; and television digital station transmitters.
4017 Cell service areas should also be leveraged with a notion that it is better to send alerts and warnings into
4018 an area rather than failing to attempt communications. This information is important when issuing AWN as
4019 the IPAWS architecture shows multiple pathways for sending and receiving an alert. However, it is still
4020 important to note that A&W capability can be significantly impacted by damage to the communications
4021 infrastructure.

4022 The effects of a nuclear detonation could last from days to months, sometimes up to a year in some cases.
4023 The key to providing timely, comprehensive AWN and precise protective actions to those inside and outside
4024 the HZ is based on plume predictions (the area in which acute radiation effects such as radiation sickness
4025 can be expected). It is an area in which controls to mitigate exposures should be considered. It is also
4026 important to note that the magnitude of the HZ will initially increase due to fallout deposition and will
4027 rapidly (hours to a few days) decrease due to radioactive decay.

4028 After detonation, the public in the HZ should have received warnings, however those in this area should
4029 continue to receive A&Ws to take protective measures. For areas where there is significant exposure,
4030 possible damage, and complete destruction of cell towers, loss of electrical power and internet accessibility
4031 in the affected, it is critical to use alternative networks and transports (i.e., satellite or other means) to get
4032 the AWN information out. Planners and responders should look outside the HZ for other EOCs, state,
4033 regional or national assets who can perform the A&W function based on prior MOAs or multi-jurisdictional
4034 agreements. It is also possible that since the incident is localized, there's a significant part of the country
4035 including the IPAWS-OPEN primary and cloud-based servers that can still be useful based on access to
4036 internet and other critical pathways. Broadcasts from AM and FM radio stations should continue to be
4037 emphasized.

4038 In addition, emergency planners should ensure all multi-jurisdictional, local, state, and regional MOAs and
4039 MOUs are in place.

4040 Issues involving cybersecurity, hacking, and concerns identified in the *DHS Strategy for Protecting and*
4041 *Preparing the Homeland Against Threats of Electromagnetic Pulse (EMP) and Geomagnetic Disturbances*
4042 *(GMD)* highlight threats against infrastructure. These concerns are further highlighted in a title in the

4043 *FY2020 National Defense Authorization Act (NDAA)* as it relates to AWN. This legislation has the effect that
4044 planners must continue to incorporate multiple paths to send and receive AWN and other emergency
4045 messaging.

4046 In planning for AWN, the pre-detonation goal is to issue a warning within tens of minutes before the event –
4047 a Presidential message from both NAWAS and the NPWS. It would be followed by local alerting to get out
4048 numerous 90 and 360-character WEAs and EAS as soon as possible using pre-scripted messages. It is
4049 critical that alerting authorities have been trained, are proficient and have validated that their certificates
4050 are always up to date with the IPAWS PMO. The exact message texts for these WEA and EAS alerts are the
4051 topic of several FEMA workshops held with technical experts. The goal is to publish this information in the
4052 future as well as coordinate with the authors on a new version of *Communicating in the Immediate*
4053 *Aftermath*.

4054 Since the mandated shelter alert "Get Inside, Stay Inside, Stay Tuned" needs to go out immediately, it is
4055 literally based on where the upper winds are blowing and EVERYONE downwind (how far depends on the
4056 yield and height) should receive the shelter notice. It is important to note that the IMAAC product displays
4057 all the characteristics of the HZ as it moves over time. New tools under development by DHS may be able to
4058 provide additional information based on forecasted winds at various altitudes.

4059 For post-detonation estimates, the IMAAC⁵³ will distribute an initial product to all EOCs, JICs, and JOCs
4060 within 15 to 30 minutes. IMAAC's initial product will kick-start the post-detonation operational planning.
4061 Once communication can be established with the IMAAC, more detailed estimates will be available an
4062 initial product to all EOCs, JICs, and JOCs to support operational planning and more detailed protective
4063 action messages.

4064  Action Item

4065 Examine assets outside of expected HZs, to assess back up resources and redundancies.

4066 If the incident is localized, a significant part of the country (including IPAWS-OPEN servers) may remain
4067 useful, based on access to internet and other critical pathways. Broadcast from AM and FM radio are a very
4068 important sources of AWN.

4069 In summary, planners must operationalize A&W with full knowledge of their alerting capability and the
4070 status of all critical infrastructure that could be impacted by a nuclear detonation.

4071  Action Item

4072 Ensure AWN is operationalized using regular AOT tools and emerging technologies.

⁵³ IMAAC is part of the Defense Threat Reduction Agency.

4073 Appendix 1.1: EMP, HEMP, and GMD

4074 The topic of EMP has received significant coverage in publicly available publications, with several of the
4075 important aspects not well identified. This brief synopsis is intended to clarify the topic that is covered in
4076 this FEMA Planning Guidance document, as well as to provide context for questions that are likely to arise.

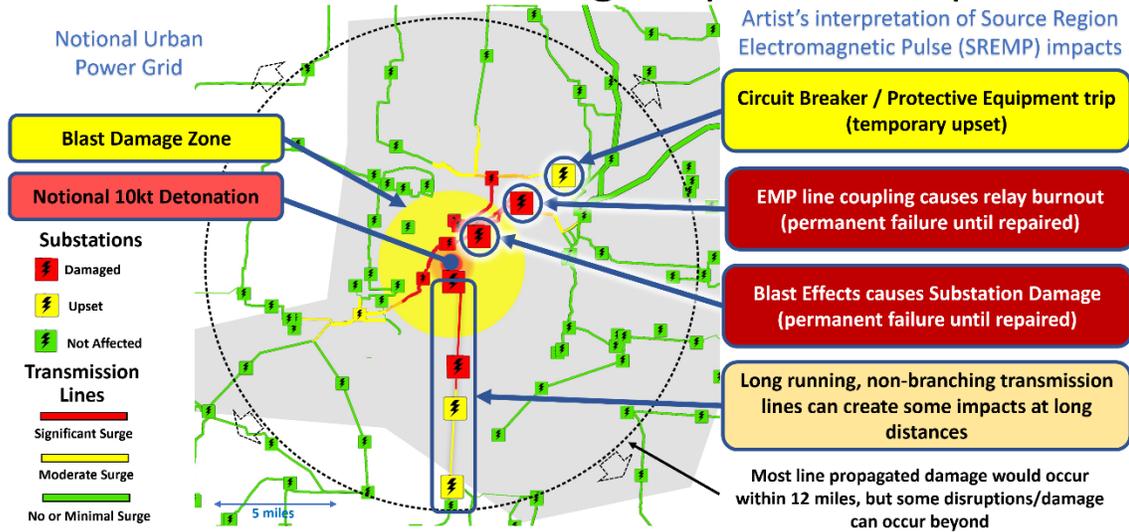
4077 1. Low-Altitude SREMP

4078 SREMP is generated in the region near low-altitude nuclear detonations less than 5 km (~3 miles) above
4079 ground level and is the focus of this guidance document. SREMP is caused by the radiation interacting with
4080 the air molecules, creating a charge separation with the associated electric fields. The SREMP electric
4081 fields can be very high but fall off rapidly with distance from the detonation. When mapped against blast
4082 damage, the SREMP fields tend to be low once outside the SDZ radius. SREMP is predominantly E1 but
4083 includes some of the E2 characteristics, although E1 aspects dominate the EMP damage concerns.

4084 There are two major disruptive effects from the SREMP that must be taken into consideration:

- 4085 1. Radiative effects in which the electromagnetic fields produced by the detonation travel through the air
4086 and can affect electronic equipment through induced voltage and current on its internal wires and
4087 conductors. The radiative threat for SREMP is limited by the strength of the electric field generated and
4088 the distance to which this field can damage or upset to electrical equipment. Different types of
4089 equipment have different thresholds for damage or upset. SREMP damaging radiative effects extend
4090 roughly as far from the detonation as the SDZ.
- 4091 2. Coupled line charges create large voltage and current surges in long running power lines and other
4092 conductors that pass near the detonation point. SREMP coupled to long conductors, such as power
4093 lines, can travel significant distances, depending on the topology of conductors, so the discussion here
4094 is generalized. For example, a power system with few branching connections can conduct an electrical
4095 pulse for several tens of miles, while a power system with more branching can only carry a pulse a few
4096 miles. Coupling with transmission lines and into substations can potentially damage transformers or
4097 burn out relays up to 12 miles away. Actual impacts will depend on the specific layout of the electric
4098 grid, this can be seen in the notional example shown in Figure 37. For example, in an analysis of three
4099 different U.S. cities, expected damage ranged from about 2 miles to 22 miles, depending on the grid
4100 design. Similarly, expected substation circuit breaker trips ranged from about 3 miles to 60 miles.

Transmission line resistance and junctions reduce the distance at which surge impacts are expected



4101

4102

Figure 37: Notional SREMP impacts on an electrical grid.

4103 Equipment attached to commercial power can experience damage 5-10 miles from the detonation,
 4104 depending on electric power system characteristics. Back-up power and surge protection can mitigate this
 4105 impact.

4106 Power outages are likely in low-altitude nuclear detonation scenarios. Outages are influenced by a number
 4107 of factors including the extent of physical damage caused by the detonation and the power system design.
 4108 In general, the outages evolve as follows. The detonation causes blast damage and SREMP effects. The
 4109 electrical system experiences an imbalance of too much load, too much generation, or a combination of
 4110 both. The system will begin to compensate for this situation but is unlikely to balance the system
 4111 immediately. Subsequently, the system will shed more load. This results in a cascading outage that extends
 4112 well beyond the damage zones. The power system will eventually stabilize and power will be restored where
 4113 the system has not been physically damaged. Utilities will restore electric power to undamaged areas in a
 4114 reasonably short time – typically hours to a few days. Repair and restoration where physical damage
 4115 occurred will take longer and depend on fallout considerations for workers.

4116 The approximate range of SREMP effects in a 10 kT scenario can be seen in Chapter 1, Figure 19.
 4117 Electromagnetic illumination effects, such as permanent failure and temporary damage, are generally
 4118 contained within the blast damage zones. Notably, this will only effect some of the equipment in the area.

4119 The distances discussed above are applicable for a wide range of nuclear yields. The physics of a SREMP
 4120 environment is only weakly dependent on yield, so distances change very little for yields ranging from 10 kT
 4121 to 1000 kT. This is in striking contrast to the blast damage discussed earlier in this document.

4122 **2. HEMP**

4123 High altitude nuclear detonations can produce three EMP components. The first component, called E1, is
4124 generated by the initial gamma radiation interacting with the air molecules. This effect results in a rapidly
4125 rising high magnitude, short duration electric field. HEMP E1 can be a strong electric field (several kilovolts
4126 per meter) and can exist over a large area (perhaps a couple of states). Unprotected electronic devices
4127 may be damaged or electrically disrupted, requiring reset or power cycling, though devices connected to
4128 long conductors are at greater risk.

4129 The E2 component is generated by scattered gamma rays and neutrons interacting with the air molecules
4130 to create a second pulse, slightly later than E1 (beginning at about a microsecond and extending to
4131 many milli-seconds). The E2 component is like the electric field created by a nearby lightning strike.
4132 Subsequently, the E2 component is often not included in EMP assessments because lightning protection
4133 devices mitigate its effects.

4134 The E3 component is composed of two different effects. The first is the blast effect in which the expanding
4135 plasma ball from the detonation disturbs the Earth's magnetic field — much like a magnetic bubble
4136 separating the magnetic field lines— thus creating an electric field. The second part of E3 is the heave
4137 effect resulting from two phenomena: (1) X-rays create a heated, conductive patch in the atmosphere,
4138 which then deflects the Earth's magnetic field lines creating an electric field and (2) beta radiation works
4139 in concert with bomb debris to create an electric dynamo in the upper atmosphere to create an electric
4140 field. The heave effect is analogous to that created by solar activity which can result in significant
4141 geomagnetic disturbances. In either case, the E3 portion of EMP results in a low frequency electric field,
4142 with relatively low magnitude (volts per kilometer). The effects of E3 are described below in the GMD
4143 section.

4144 **3. GMD**

4145 GMDs can create low frequency electric fields like those created by EMP E3, which can couple to long
4146 conductors, like power transmission lines, resulting in low frequency electric currents. GMD incidents can
4147 last several minutes, hours, or days, and can cover large areas. The primary GMD threat large power
4148 transformers overheating, so the duration of GMD effects is a critical issue.

4149 Appendix 1.2: Residual Radiation 4150 Variability

4151 The fallout plume from a nuclear detonation can behave unpredictably and is strongly affected by the
4152 environment. This appendix describes some reasons why residual radiation levels may vary from model
4153 predictions or initial estimates.

4154 1. Residual radiation fields (HZ and DRZs) differ greatly 4155 based on contextual variables

4156 HZ and DRZ behavior vary depending on:

- 4157 ▪ Nuclear yield and HOB
- 4158 ▪ Environmental characteristics, such as those listed below, impact the amount of debris, fallout particle
4159 size, cloud lofting, and fallout particle settling, that in turn, affect the downwind patterns of residual
4160 fallout radiation:
 - 4161 ○ Urban, sub-urban, soil, desert conditions
 - 4162 ○ Underground cavities like parking structures, building basements, tunnels, exposed rock formations
 - 4163 ○ Coastal/shoreline, river, harbor, open ocean settings. (For example, near-surface detonations over
4164 water may produce lower residual radiation exposure rates compared the same nuclear yield and
4165 HOB over land).
 - 4166 ○ Grassland/forest settings
- 4167 ▪ Meteorological conditions can greatly affect the cloud rise, fallout, and residual radiation, including the
4168 following:
 - 4169 ○ Surface-level and upper-level wind speed and direction affect the direction and downwind extent of
4170 fallout patterns at local, regional, and continental-scale distance
 - 4171 ○ Precipitation can cause rainout and washout of airborne particles and produce areas of significant
4172 ground contamination. HZs/ DRZs may require emergency operations in areas that did not suffer
4173 blast damage, initial radiation, or local fallout. Hot spots of ground contamination caused by
4174 washout and rainout of airborne particles may generate additional HZs and DRZs that are
4175 geographically separated from the local fallout HZs and DRZs.
 - 4176 ○ Winds, temperature, and humidity as a function of altitude will affect how high the cloud will rise,
4177 which then affects the direction and extent of residual radiation fallout fields.

- 4178 ○ Changing wind conditions may cause resuspension of fallout particle back into the air, resulting in
- 4179 changing DRZ and HZ boundaries over time (this effect is unpredictable and difficult to model).

4180 2. Meteorological conditions may cause significant

4181 variations in fallout patterns

4182 Fallout patterns will vary greatly due to meteorological conditions. For example, wind shear⁵⁴ can result in

4183 irregularly shaped ground contamination areas, and corresponding DRZs and HZs; additionally, land-sea

4184 breezes can generate wind directions at higher altitudes 180 degrees opposite those observed on the

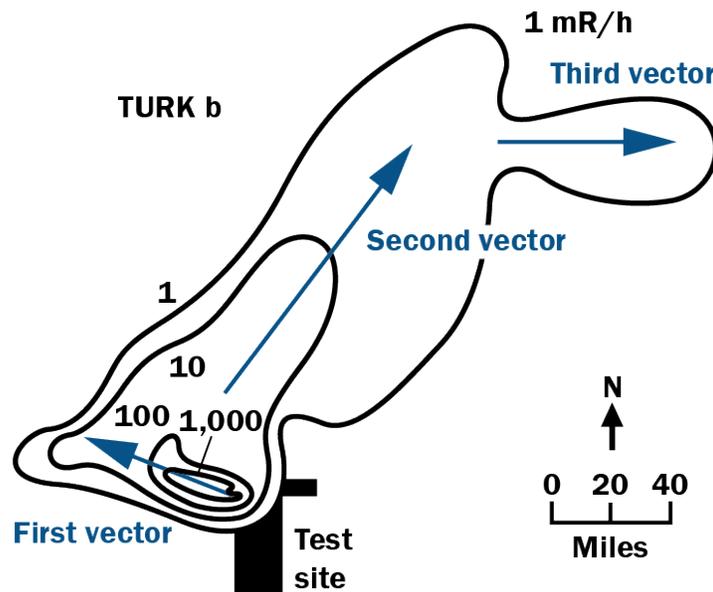
4185 ground. Such wind-shear influence was observed in U.S. historical nuclear testing, even when shot times

4186 were selected for simpler weather conditions. Figure 38 depicts the complex wind-induced fallout pattern

4187 from Teapot Turk, a 43 kT nuclear test detonated at 500 ft above the surface of the Nevada Test Site (NTS).

4188 The three wind vectors in Figure 38 show dramatically different wind directions at different altitudes, which

4189 produced three different lobes in the fallout pattern on the ground.



4190

4191 **Figure 38: Early fallout dose-rate contours from the TURK test at the NTS (derived from Glasstone,**

4192 **1977).**

4193 Rainout of airborne radioactive particles may generate additional HZs and DRZs that are geographically

4194 separate from the local fallout. These separate HZs and DRZs could still be within the local emergency

4195 response area, while outside the physical damage zones. They may affect populations much farther

4196 downwind, in neighboring jurisdictions.

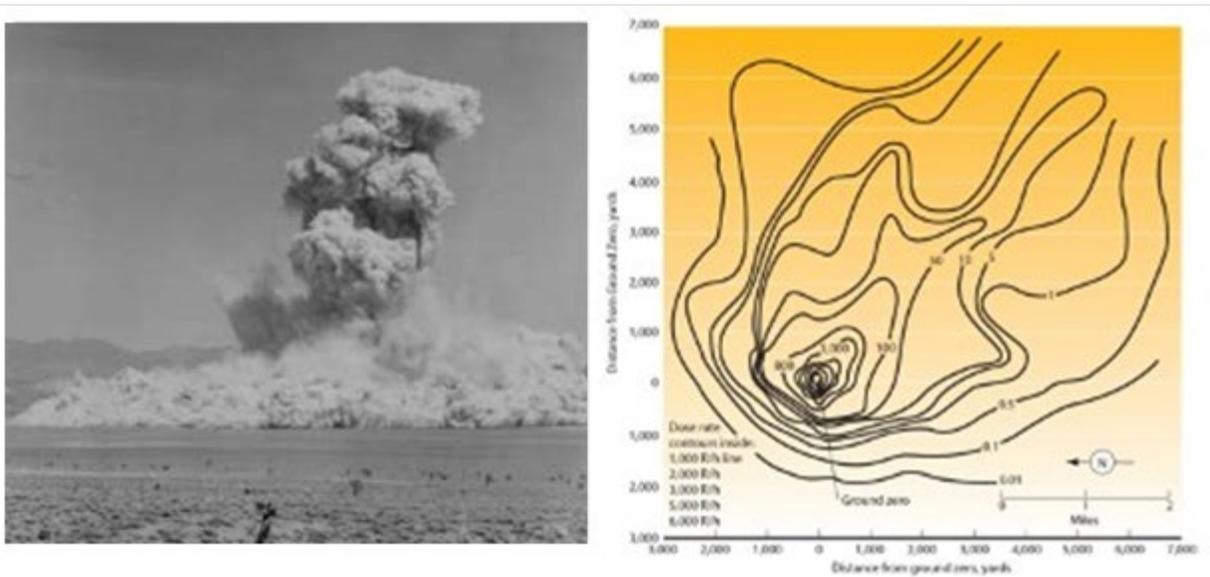
⁵⁴ Wind direction and speed changes with altitude.

4197 **3. Fallout clouds and patterns from a nuclear detonation in**
4198 **an urban environment may vary significantly from**
4199 **nuclear tests**

4200 Nuclear fallout clouds from detonation in or near urban structures or underground, such as in a subway
4201 tunnel or parking structure, may be quite different than above ground tests. Urban and underground
4202 detonation may not produce the classic mushroom cloud shape due a number of factors, including:

- 4203 ▪ Urban and underground material incorporation into the fireball
- 4204 ▪ Surrounding buildings partially blocking fallout cloud airflow
- 4205 ▪ Blast waves reflecting off nearby buildings
- 4206 ▪ Fireball interacting with building surfaces

4207 For example, a non-mushroom shaped cloud can be seen in Figure 38, depicting a nuclear test performed
4208 at the Nevada Test Site in 1955, called Teapot ESS. This 1 kT device was detonated 67 feet underground.
4209 The irregularly shaped fallout cloud climbed more than two miles in about five minutes and maintained a
4210 wide, irregular pattern as it traveled downwind. In the Teapot ESS case, fallout contamination on the
4211 ground after the test produced dose rates of more than 10 R/hr approximately 3.5 miles away, 1 hour after
4212 the detonation.



4213 **Figure 39: (Left panel) The 1 kT Teapot ESS test, conducted on March 23, 1955. (Right panel)**
4214 **Map of fallout dose rates recorded 1 hour after Teapot ESS.**
4215

4216 **Appendix 2.1: Alternative Techniques** 4217 **to Determine Dose**⁵⁵

4218 For most emergency workers, the only operational dose and dose tracking information used may be based
4219 on their time at specific locations, matched to an estimate of radiation levels at those locations during
4220 those times.

4221 Planners should establish a method for emergency response officials to account for all emergency worker
4222 radiation doses. Initial steps to address this are:

- 4223 1. Creating a communication framework for emergency workers that will enable dissemination of dose-
4224 related information.
- 4225 2. Informing all emergency workers of the critical need to manage dose.
- 4226 3. Evaluating dose estimation and measurement resources available in advance of an incident and
4227 providing relevant training/guidance.
- 4228 4. Obtaining or developing additional or improved dosimetry methods as needed. Dosimeters should be
4229 distributed to emergency workers when available.
- 4230 5. Specifying how radiation dose measurements/estimates will be documented, so workers can protect
4231 themselves and emergency response officials can make well-informed decisions.
- 4232 6. Establishing recordkeeping practices to account for every worker's dose as it accumulates. This will
4233 enable emergency workers to minimize dose and ensure relevant countermeasures are provided if
4234 thresholds are exceeded.

4235 Due to the lack of time to obtain and issue dosimetry equipment; extreme infrastructure damage; and the
4236 scale of dosimetry needs; it is not practical to ensure every emergency worker is issued a dosimeter before
4237 exposure to radiation. Regardless, plans must include guidelines for addressing dosimetry needs. For
4238 example, emergency workers may repurpose equipment that was not specifically designed to estimate and
4239 control dose, such as preventative radiological/nuclear detectors. If there are not enough dosimeters,
4240 group dosimetry may be necessary, where individual doses may be assigned using one person's dose
4241 assessment as a surrogate for others in the same group or vicinity.

4242 **1. Dosimetry in the Early Phase of the Response**

4243 Although radiation levels can change rapidly with location, monitoring occupancy time is an essential
4244 exposure control tool when radiation levels are relatively uniform over time and location. The standard ICS
4245 accountability system can be used to track individual/group dose. However, during complex incidents, it is

⁵⁵ This entire appendix is derived from NCRP Report No. 179, *Guidance for Emergency Response Dosimetry*, and Reprinted with permission of the National Council on Radiation Protection and Measurements, <https://ncrppublications.org/>.

4246 necessary to establish a separate dose tracking or data management unit within the ICS structure. Dosimetry
4247 plans must include information gathering from the beginning of the incident, for future dose reconstruction.
4248 If early data are recorded, it will facilitate dose reconstruction to determine emergency workers' doses. If
4249 early ICS record-keeping is not comprehensive, it will introduce uncertainties.

4250 In the early response phase (first hours and days), important ICS dosimetry roles and responsibilities
4251 include:

- 4252 1. Allocate and prioritize limited monitoring equipment based on expected radiation levels, mission
4253 time, and equipment capabilities.
- 4254 2. Maximize dose monitoring coverage, despite limited equipment, by issuing one piece of equipment for
4255 each group of responders that deploys, works, and returns together. Group dosimetry is similar to
4256 issuing radios and communication devices to responder's groups. Not everyone gets a radio, but it is
4257 assumed that all responders will be near their team member/partner with a radio. Radios are issued
4258 to ensure maximum coverage and safety— monitoring equipment can be viewed the same way.
- 4259 3. Establish and implement dose tracking procedures.
- 4260 4. Maintain detailed location records of where responders work on the incident and for how long to
4261 facilitate later dose reconstruction.
- 4262 5. Provide responders with monitoring equipment and relevant training, to the greatest extent possible.
4263 During the early response phase, it is acceptable to conduct operations with limited dose
4264 measurement capabilities, provided ALARA is practiced, and available monitoring and dose tracking
4265 resources are optimized.
- 4266 6. Utilize radiological/nuclear detection equipment to support dose control and monitoring, provided the
4267 equipment can perform that role. Tables 10 and 11 summarize equipment types and their operation and
4268 capabilities.
- 4269 7. Ensure dose reconstruction data is available by tracking responder locations and times, even when
4270 radiation levels are unknown.

4271 **Table 10: Equipment for Emergency Worker Dose Monitoring**

| Equipment | Description | Responder Dose Monitoring and Control Applicability | Features and Components |
|------------------------|--|---|---|
| Handheld survey meters | <p>A very broad category of equipment.</p> <p>Typically used to monitor contamination or radiation in the workplace.</p> <p>Operational range and readout units depend on specific configurations.</p> | <p>Advantages: This broad category of survey meters have been used in radiological and nuclear facilities for decades and therefore have a broad occupational worker user base that understands their use.</p> <p>Limitations: The occasional user, such as an emergency worker, may find using these devices confusing because many display several orders of magnitude on the scale. Correct interpretation requires an understanding of which probe is attached and how to change (and multiply) the scale of the reading.</p> | Geiger-Muller (GM) detectors, ion chambers, and scintillator-based handheld meters. |
| Personal dosimeter | <p>A small radiation monitor worn by an individual. These robust, passive devices only provide an assessment of accumulated personal dose after being processed by a laboratory.</p> | <p>Advantages: Records personal dose equivalent with accuracy similar to that needed for power plants or similar industrial uses. Some dosimeters can be read with portable equipment, enabling immediate field readings.</p> <p>Limitations: Only records accumulated exposures and does not help the responders avoid exposure (i.e., lacks real-time displays and alarms).</p> | Common individual dosimeters contain film, thermoluminescent dosimeter (TLD), optically stimulated luminescent materials (OSL), or direct-ion storage (DIS) |

| Equipment | Description | Responder Dose Monitoring and Control Applicability | Features and Components |
|---|---|---|---|
| Pocket ionization chamber | <p>Small devices worn by an individual.</p> <p>Typically, the size of a large pen and comes in a variety of exposure ranges. Also known as quartz-fiber dosimeters, self-indicating pocket dosimeters, or self-reading pocket dosimeters.</p> | <p>Advantages: Minimal maintenance and can operate without batteries. Can be read in the field to provide real-time accumulated exposure information to the user.</p> <p>Limitations: Must be charged before use, and all readings must be recorded at the end of the mission, as the device does not retain a record. These do not warn workers of hazardous conditions. Difficult to read in the field, especially when wearing a respirator or self-contained breathing apparatus. May provide false readings if subjected to mechanical shock. Comes in a variety of dose ranges, requiring careful selection.</p> | <p>Looking through the device, users can see a needle indicating exposure level.</p> |
| Electronic personal dosimeter (EPD) | <p>Worn by an individual to measure personal dose equivalent. Displays dose and dose rate, and many will alarm when preset thresholds are exceeded.</p> | <p>Advantages: Provides immediate information and alarm functions to control exposure. Since these can display exposure rate, they also can be used as high-range survey instruments.</p> <p>Limitations: Many of these are too fragile for the rigors of emergency response - these devices lack large displays, vibration, or loud audible alarms. Difficult to change alarm set points in the field or reset dose accumulation between missions. The American National Standards Institute (ANSI) standard requires measurements up to 100 R/hr and 100 R, although many devices exceed this.</p> | <p>Typically use semiconductor detectors such as a metal-oxide semiconductor field-effect transistor.</p> |
| Personal Emergency Radiation Detectors (PERDs) and Monitors | <p>Worn by an individual to measure personal exposure. PERDs display dose and dose rate and will alarm if preset thresholds are exceeded.</p> | <p>Advantages: PERD ranges are appropriate in the elevated radiation area, HZ, and DRZ, making them the preferred tool to ensure responder safety. PERD accuracy is the same as EPDs, but the higher range (0.001 to 999 R/hr) ensures the instrument will not oversaturate. Built to endure the hardships of emergency response. Vibration and loud audible alarms. Field adjustable parameters.</p> <p>Limitations: The ANSI standard for PERDs requires an effective dose-rate range down to 1 mR/hr, which may limit their use in the elevated radiation area, although many devices have a larger effective range.</p> | <p>These instruments typically use a small Geiger-Muller tube or solid-state detector.</p> |

| Equipment | Description | Responder Dose Monitoring and Control Applicability | Features and Components |
|--|--|--|--|
| <p>Personal radiation detectors (PRDs)</p> | <p>Similar in appearance to electronic dosimeters; PRDs detect low levels of radiation for law-enforcement activities. Developed to help find and intercept potential radiological/ nuclear threats.</p> | <p>Advantages: Alerts wearers to any low levels of radiation. Useful for emergency response activities outside of the HZ.</p> <p>Limitations: The ANSI standard (ANSI 2011) does not require tracking integrated or cumulative exposure, although some manufacturers add this capability. The standard requires an exposure rate range up to 2 mR/hr. Due to their sensitivity, these devices often saturate at relatively low radiation levels and cannot be used in the HZ or DRZ.</p> | <p>Typically use very sensitive crystal or plastic scintillators.</p> |
| <p>Extended range PRDs</p> | <p>PRD manufacturers have begun offering dual detector systems that allow the PRD to have an extended (high) dose-rate range without sacrificing the lower dose-rate sensitivity.</p> | <p>Advantages: If designed to track exposure rate and total exposure, it would be an appropriate tool for responder protection and monitoring in the HZ and DRZ (if the device can support exposure rates up to 500 R/hr). A reasonable tool for both public safety and security applications.</p> <p>Limitations: Alarm set points must be changed to match mission needs — preset thresholds would negatively impact emergency response operations.</p> | <p>In addition to sensitive crystal or plastic scintillators, manufacturers often add a second, less sensitive detector such as a small Geiger-Muller or solid-state detector.</p> |

4272 **Table 11: Mission-Oriented Detector Selection (adapted from NCRP 2017 Table 4.4 and FEMA 2010 Table)**

| Mission | Personal Dosimeter | Pocket Ionization Chamber | Alarming Electronic Personal Detector (EPD) | Personal Radiation Detector (PRD) | Extended Range PRD | Personal Emergency Radiation Detector (PERD) | Low-Range Survey Meter | High-Range Survey Meter | Radioisotope Identification Device | Large Mobile and Transportable | Aerial | Portal Monitor | Backpack | Sensor Networks | Medical Instrumentation |
|---|---------------------|---------------------------|---|-----------------------------------|-----------------------|--|------------------------|-------------------------|------------------------------------|--------------------------------|--------|----------------|----------|-----------------|-------------------------|
| Cold zone [less than ~0.1 mGy h⁻¹ (10 mR h⁻¹)] | | | | | | | | | | | | | | | |
| Emergency worker exposure control | ⊙ ○ ^D | ○ | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ⊙ | ⊙ | ⊙ | ● ^A | ⊙ |
| Emergency worker dose monitoring | ● | ○ | ● | ⊙ ● ^A | ⊙ ● ^A | ● | ⊙ ○ ^A | ⊙ ○ ^A | ⊙ ○ ^A | ⊙ | ⊙ | ⊙ | ⊙ | ● ^A | ⊙ |
| Contamination screening (β/γ) | ⊙ | ⊙ | ○ | ● | ● | ⊙ ● ^B | ● | ○ | ● | ● | ⊙ | ● | ○ | ⊙ | ⊙ |
| Radiation survey (cold zone only) | ⊙ | ⊙ | ⊙ | ○ ● ^C | ● | ○ ● ^B | ● | ○ | ● | ● | ● | ⊙ | ○ | ● ^A | ⊙ |
| Radiation Monitoring at Shelters | ⊙ | ⊙ | ○ | ● | ● | ● | ● | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ |
| Establish Evacuation Routes | ⊙ | ⊙ | ● | ● | ● | ○ | ○ | ● | ○ | ○ | ● | ⊙ | ○ | ○ | ⊙ |
| Population Monitoring at Medical Facilities | ⊙ | ⊙ | ○ | ○ | ● | ● | ○ | ⊙ | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ○ |
| Hot zone [>0.1 mGy h⁻¹ (10 mR h⁻¹)] | | | | | | | | | | | | | | | |
| Emergency worker exposure control | ⊙ ○ ^D | ○ | ○ ● ^G | ⊙ | ○ ● ^H | ● | ⊙ | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ● ^E | ⊙ |
| Emergency worker dose monitoring | ● | ○ | ○ ● ^G | ⊙ | ⊙ ● ^{A,E} | ● | ⊙ | ⊙ ○ ^A | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ● ^E | ⊙ |

continued on next page

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(continued)

| Mission | Personal Dosimeter | Pocket Ionization Chamber | Alarming Electronic Personal Detector (EPD) | Personal Radiation Detector (PRD) | Extended Range PRD | Personal Emergency Radiation Detector (PERD) | Low-Range Survey Meter | High-Range Survey Meter | Radio-isotope Identification Device | Large Mobile and Transportable | Aerial | Portal Monitor | Backpack | Sensor Networks | Medical Instrumentation |
|---|--------------------|---------------------------|---|-----------------------------------|--------------------|--|------------------------|-------------------------|-------------------------------------|--------------------------------|--------|----------------|----------|-----------------|-------------------------|
| Radiation survey (hot zone only) | ⊙ | ⊙ | ○ | ⊙ | ○ | ● | ⊙ | ● | ⊙ | ⊙ ^E | ● | ⊙ | ⊙ | ● ^F | ⊙ |
| Dangerous-radiation zone [$>0.1 \text{ Gy h}^{-1}$ (10 R h^{-1})] | | | | | | | | | | | | | | | |
| Emergency worker exposure control | ⊙ | ○ | ○ ^{F, G} | ⊙ | ● | ○ ^{F, G} | ⊙ | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ● ^F | ⊙ |
| Emergency worker dose monitoring | ● | ○ | ○ ^{F, G} | ⊙ | ● | ○ ^{A, G} | ⊙ | ⊙ ^A | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ● ^F | ⊙ |

^aSymbol key:

- = Useful; Appropriate for the mission
- = Marginal; meets minimum requirement
- ⊙ = Not useful; insufficient for the mission
- A = Provided instruments have the capability to track accumulated exposure or dose
- B = Provided instruments have the capability for low-range [down to $\sim 1 \mu\text{Gy h}^{-1}$ (0.1 mR h^{-1})] exposure monitoring
- C = Provided instruments can readout in exposure or dose rate and do not automatically adjust for background
- D = Provided the dosimeter has the capability for readout in the field
- E = Provided instruments have the capability for high-range [up to $\sim 0.1 \text{ Gy h}^{-1}$ (10 R h^{-1})] functionality
- F = Provided instruments have the capability for very high-range [up to $\sim 10 \text{ Gy h}^{-1}$ ($1,000 \text{ R h}^{-1}$)] functionality
- G = Provided instruments have the loud audible and vibration alarm

Useful – This is a device that can effectively perform the designated mission or task without modification of the device or of its normal mode of employment. In a sense, the device was designed or intended for that mission or task.

Marginal – The device can provide useful and relevant data in support of the designated mission or task but with modification to the normal mode of employment. In addition, its use may create a potentially unsafe condition to the user of the device. This implies a need for care in the interpretation of the data produced by such a device under the circumstances.

Not Useful – While the device is capable of detecting nuclear radiation, its technical performance characteristics or conditions of use are such that it is unlikely to be able to provide useful information in support of the designated mission or task. In addition, its use may create a grossly unsafe condition to the user of the device.

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Appendix 2.2: Decontamination of Critical Infrastructure

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Several factors should be considered when assessing decontamination needs:

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1. The DRZ may involve lethal, non-uniform fallout deposition, or hot spots. Responders working in areas with significant fallout contamination require real-time radiation measurements and a robust, actively managed personal dose-monitoring system.

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2. Fallout decays rapidly (see Chapter 1), so it is generally preferable to delay decontamination efforts if possible. Temporary solutions to reduce exposure to workers at critical infrastructure facilities include:

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a. Burying radioactive contamination by tilling contaminated soil in the surrounding area. Leaving the tilled soil rough reduces radiation exposure.

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b. Adding or enhancing shielding (heavy materials) around key locations of interest. Consider use of concrete highway barriers and/or earthen and rubble berms.

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4288

c. Washing/Spraying down vegetation (e.g., trees) and other elevated surfaces.

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3. Where possible, infrastructure outside the HZ and DRZ should be used. These facilities and locations could be available immediately and can be expected to be free of contamination.

4290

4291

FEMA's Continuity of Operations Program (COOP) guidance and planning resources can be used as a template for local emergency preparedness planners and can help them choose appropriate COOP locations that will not be affected by fallout or require decontamination.

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4. If decontamination is required in the early hours after a nuclear explosion, local responders, may perform these duties, despite little or no radiological decontamination training.

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5. Consider effective, fast, and easy to implement decontamination methods, such as vacuuming, showering, and hosing.

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Refer To

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FEMA COOP Brochure: https://www.fema.gov/pdf/about/org/ncp/coop_brochure.pdf

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Critical infrastructure decontamination should only be initiated when basic information becomes available regarding fallout distribution, current and projected radiation dose rates, and structural integrity of the elements to be decontaminated. In this early phase, rather than planning in detail, it may be desirable to choose decontamination methods based on historical research findings and trustworthy resources.

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4304

4305 It is important to estimate how much decontamination is required to use or occupy each area, and
4306 how long each area must be used. Emergency response and SLTT officials must determine which
4307 infrastructure requires decontamination and what level of decontamination is necessary. Planners
4308 must consider the level of effort, responder exposure, PPE availability, and waste management.
4309 Natural decay of radioactive contaminants must be accounted for in dose estimates.

4310 Early infrastructure decontamination is intended to remove a substantial portion of contaminant, to
4311 lower radioactivity and facilitate use or occupancy. Effective decontamination methods utilize
4312 equipment and operator skills that are immediately available, such as:

- 4313 6. Vacuuming/vacuum sweeping
- 4314 7. Fire hosing/rinsing
- 4315 8. Washing with detergents or surfactants
- 4316 9. Steam cleaning
- 4317 10. Surface removal using abrasive media (e.g., sandblasting)
- 4318 11. Vegetation and soil removal
- 4319 12. Road resurfacing

4320 In general, more effective methods take longer and require more skilled operators. The above
4321 methods have been demonstrated to remove 20-95% of existing contamination in various conditions,
4322 but many factors must be considered to select the most effective method.

4323



Refer To

4324

For more information on method selection, see [NCRP Report 175, Decision Making for Late-Phase Recovery from Major Nuclear or Radiological Incidents](#).

4325

4326

Appendix 2.3: Waste Management Operations

4327

4328 A nuclear explosion will generate large quantities of waste and debris. Moreover, decontamination
4329 and cleanupefforts will also generate waste. All wastes will require proper characterization,
4330 segregation, transportation, and disposal. Waste streams will be highly variable, ranging from building
4331 debris and contents (concrete rubble, soil, structural metal, asbestos-containing materials, carpets,
4332 wallboard, electronics, etc.) to contaminated fluids, sludge, animal carcasses, vegetative debris, and
4333 human remains.

4334 Decontamination decisions can profoundly impact waste disposal options and waste quantities.
4335 Additionally, waste disposal costs and legal or practical barriers may impact the decontamination
4336 strategies. SLTT waste management personnel should be included in the planning process to advise
4337 responders, develop an understanding of likely debris, and identify appropriate equipment to remove
4338 obstacles and obstructions. State and local waste management personnel should pre-select
4339 potential site(s) for short-term waste storage. Waste management plan should include messaging to
4340 address the public affected by waste storage or transportation. Some debris and waste piles may
4341 contain human remains, which will require special handling procedures.

4342 Traditionally, waste management operations begin after lifesaving operations, situation stabilization,
4343 and evidencecollection. However, during a large-scale incident like a nuclear explosion, waste
4344 management operations will overlap with search and rescue, criminal investigations, and human
4345 remains recovery.

4346 During initial roadway clearance, the priority will be to push debris to the sides of the road and
4347 provide access, rather than removing the debris to staging or holding areas. Given limited resources
4348 in the first 72 hours, it is more important to clear access routes for emergency vehicle movement
4349 than to begin debris removal operations. Waste management personnel may relocate debris to
4350 temporary staging points, where debris can be examined for human remains and segregated,
4351 though search and segregation is not a priority in the first 72 hours.

4352 Debris downwind of the blast area will likely be radioactive, while debris far upwind will likely have
4353 little contamination. Considering the extent of debris contamination is important when determining
4354 the management methods. Plans should include measuring debris radioactivity, addressing removal
4355 equipment contamination, and avoiding co-mingling contaminated and uncontaminated debris.

4356 Hot spot removal will reduce emergency responder radiation doses, enabling them to respond for longer
4357 time periods. Hot spot removal is another waste management activity that may be necessary during the
4358 initial hours. Removing a hot spot may include washing down the area, scraping up contaminated soil,
4359 or similar removal activities. Hot spots are areas with high concentrations of radiation, posing a
4360 greater threat to response workers and the public.

4361 In summary, in the first 72 hours, planners should consider the following:

- 4362 ▪ Waste management officials must work with ICs to identify waste management priorities.
- 4363 ▪ Waste management operations must prioritize worker safety and health. Worker training must
4364 be coordinated in advance of an incident.
- 4365 ▪ Clearing debris from roads and other infrastructure will be a response priority, to facilitate
4366 lifesaving and other emergency response activities. This action will likely be limited to moving
4367 debris to provide safe ingress and egress corridors.
- 4368 ▪ Promptly removing highly contaminated materials or hot spots, may be necessary to reduce
4369 exposure.
- 4370 ▪ Locations and mechanisms must be identified for screening debris that may contain human
4371 remains. Additionally, locations and mechanisms must be established for staging, holding, short-
4372 term storing, categorizing, segregating, transporting, and preparing waste for disposal.

4373 Appendix 3.1: Shelter Protective 4374 Actions

4375 The EPA publishes PAGs for nuclear incidents. Existing PAGs can be applied outside of hazardous
4376 fallout areas, where radiation levels will not cause acute health effects.



4377 Refer To

4378 *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents:*
4379 <https://www.epa.gov/radiation/protective-action-guides-pags>



4380 Action Item

4381 Include protective action recommendation guidance, like the tiers shown here, in emergency
4382 response plans.

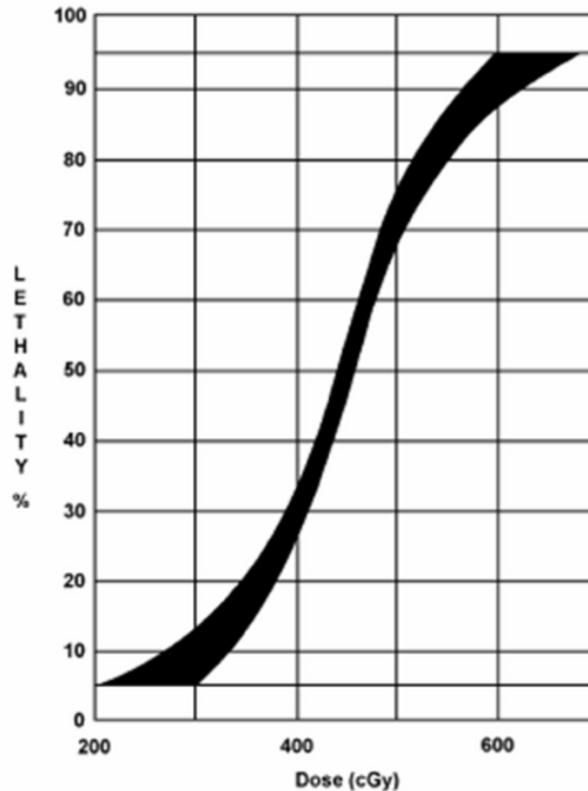
4383 Nuclear explosion impacts are complex and extensive (see Chapter 1 for a detailed discussion). No
4384 single protective action is always applicable to all locations. Therefore, planners should consider the
4385 three tiers of protective action recommendations described below in Table 12.

4386 **Table 12: Protective Action Recommendation Tiers**

| | |
|---|---|
| <p>Generic recommendations issued in advance of an incident, coupled with public education and outreach.</p> | <p>Pre-designated public shelters should be part of this strategy, especially for communities without sufficient adequate shelters.</p> |
| <p>Initial recommendations issued as soon as possible after an incident (likely based on little or no incident data).</p> | <p>Generally recommending immediate sheltering in the most protective, safe, readily available shelter (Get Inside, Stay Inside, Stay Tuned).</p> |
| <p>Follow-up recommendations issued once additional data and information become available.</p> | <p>These may include release from shelter guidance (all clear) or continued shelter for a set period followed by specific evacuation instructions for selected areas or populations. The most important information influencing these recommendations will be the fallout distribution and magnitude, known life-threatening conditions (e.g., fire and medical emergencies), and safe evacuation methods and routes.</p> |

4387 Appendix 4.1: LD_{50/60}

4388 ARS in humans can be described with [LD50/60](#), as shown in the diagram below (Figure 40). The
4389 curve below applies to victims who **do not receive treatment**. With currently available treatments and
4390 countermeasures, survival is expected to be considerably higher, and the curve will shift to the right.



4391

4392 **Figure 40: 60-day lethality curve for untreated radiation exposure. The untreated dose that**
4393 **will kill 50% of the population within 60 days (LD_{50/60}) is approximately 450 cGy (450**
4394 **rad) (derived from Multiservice Tactics Techniques and Procedures for Treatment of**
4395 **Nuclear and Radiological Casualties, 2014).**

4396 Appendix 4.2: Subsyndromes of 4397 ARS

4398 The four ARS subsyndromes described in this document are hematopoietic subsyndrome (H-ARS),
4399 gastrointestinal subsyndrome (GI-ARS), cutaneous radiation subsyndrome (C-ARS), and
4400 neurovascular subsyndrome (N-ARS). H-ARS is described in Chapter 4, section 1.4. The other 3
4401 subsyndromes are described in this appendix.

4402 1. Gastrointestinal Subsyndrome (GI-ARS)

4403 GI-ARS manifestations typically begins at whole body [radiation doses in excess of 6 Gy \(600 rad\)](#). The
4404 severity and time of onset of GI-ARS are affected by many factors including total dose received, dose
4405 rate, host factors, etc.

4406 Initially, GI-ARS symptoms include nausea, vomiting, and diarrhea, potentially causing dehydration,
4407 electrolyte imbalances, GI bleeding, and systemic infections. GI-ARS symptoms are non-specific and
4408 can be caused by other psychological or physical injuries, meaning their presence alone does not
4409 automatically signal GI-ARS. (Dainiak & Gent, 2011b) (DiCarlo & Maher, 2011)

4410 GI-ARS treatments include countermeasures for nausea, vomiting, diarrhea, infection, fluid loss, and
4411 blood replacement. Cytokines for H-ARS do not affect G-ARS manifestations directly, but H-ARS
4412 improvements may affect GI-ARS. If patients require hospitalization for GI-ARS they will likely be in
4413 the hospital for H-ARS already.

4414 2. Cutaneous Radiation Subsyndrome (C-ARS or CRS)

4415 Cutaneous radiation subsyndrome (C-ARS) occurs when significant levels of ionizing radiation
4416 penetrate deeply into tissues. Severity and time of onset depend on dose, dose rate, radiation
4417 quality, and the total body area affected. Whole body doses sufficient to cause cutaneous and
4418 neurovascular subsyndromes are typically lethal. Additionally, such doses would be sustained by
4419 people near the blast who would likely have additional lethal injuries, so treatment efforts would be
4420 futile.

4421 C-ARS presents similarly to thermal injuries and many treatment options apply to both. At high doses,
4422 C-ARS presents almost immediately, with early skin erythema (reddening of the skin) followed by a
4423 latent period (days to weeks). Later symptoms result in blisters, ulcers, itchiness, tingling, epilation
4424 (hair loss), erythema, and edema (swelling caused by fluid buildup) (Fliedner & Friesecke, 2001)
4425 (CDC, 2005). One *major difference*, detailed below, is that there may be a much greater depth of
4426 injury for radiation burns than thermal burns, requiring deep tissue management.

4427 The clinical severity and time of onset of the signs and symptoms of C-ARS depend on total dose,
4428 dose rate, radiation quality, radiation energy (the higher the energy the deeper the penetration), the
4429 precise location of the radiated skin, and the TBSA affected.

4430 Skin affected by radiation injury can become infected and require anti-microbial treatment. Similar to
4431 thermal burns, the greater the skin area affected by radiation burns, the greater likelihood of fluid
4432 loss, requiring expertly calculated fluid replacement therapy. Skin grafting may be necessary to cover
4433 larger and deeper wounds. (Dainiak & Gent, 2011b) (Rios & DiCarlo, 2020)

4434 C-ARS treatment is based on standard non-radiation induced skin injury treatment, such as anti-
4435 inflammatory agents, topical antibiotics, and antihistamines. Surgical excision may be warranted to
4436 remove ulcers and necrotic tissue. Skin grafts can also be considered.

4437 **3. Neurovascular Subsyndrome (N-ARS)**

4438 As mentioned above, whole body doses sufficient to cause cutaneous and neurovascular
4439 subsyndromes are typically lethal and most treatment efforts would be futile. For scarce resource
4440 environments – or even fair resource conditions – care for N-ARS is primarily palliative.

4441 N-ARS is caused by high dose radiation damage to the brain and blood-brain barrier.⁵⁶ N-ARS is
4442 commonly lethal hours to days post-exposure. Symptoms include headache, nausea, vomiting,
4443 confusion, altered mental status, fever, hypotension, seizures, and coma. Treatment is complex
4444 supportive care, including fluid management (usually restriction), anti-seizure medications,
4445 corticosteroids, anti-nausea medications, pain management and blood pressure management.
4446 (Dainiak & Gent, 2011b)

⁵⁶ The blood brain barrier is a semi-permeable membrane that selectively allows solutes in the blood to cross into the extracellular fluid of the central nervous system, where neurons reside.

4447

Appendix 4.3: Burn Injuries

4448

Whether from thermal or radiation injury, depth of a burn injury, where the burn is located, and %TBSA involved are keys to appropriate therapy. Burn surface area is measured relative to the TBSA, designated as %TBSA. Meanwhile, burn depths are characterized as: (D'Arpa & Leung, 2017)

4450

4451

- **Superficial (1st degree):** involving only the epidermis (surface of the skin). Typically heal spontaneously.

4452

4453

- **Partial thickness (2nd degree):** involving some portion of the dermis. Typically heal spontaneously but may evolve into full thickness burns.

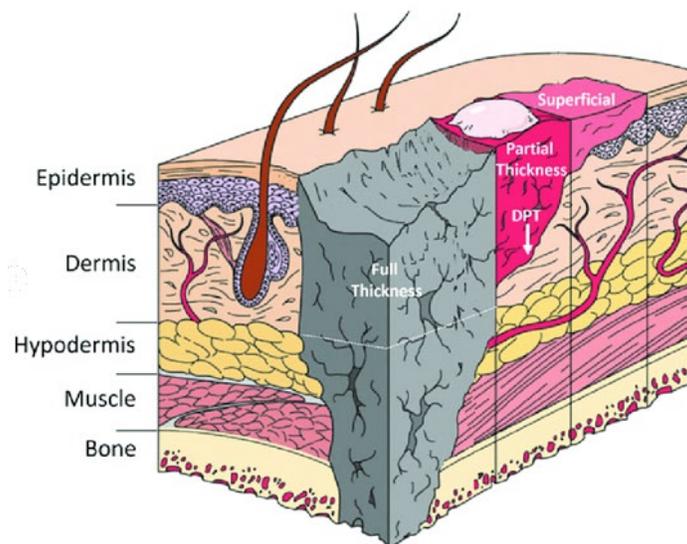
4454

4455

- **Full thickness (3rd degree):** involving the entire dermis⁵⁷, sometimes extending beyond skin tissue, down to muscle or bone. Typically require autologous skin grafting to heal well. Deep radiation burns may require deep tissue resection.

4456

4457



4458

4459

Figure 41: The layers of skin tissue, with burn-depth for different burns shown (derived D'Arpa et al., 2017)

4460

4461



Refer To

4462

[One clinical triage tool](#) on the REMM website includes burn injury input parameters.

⁵⁷ The thick layer of living tissue below the epidermis, containing blood capillaries, nerve endings, sweat glands, hair follicles, and other structures

4463 In general, the greater %TBSA covered by partial or full thickness burns and the older the individual,
4464 the greater risk of mortality. Casualties with burns >40% TBSA could survive with intense treatment;
4465 however, medical resources will be scarce following a nuclear detonation. Casualties with severe
4466 burns may not be prioritized because triage systems must allocate resources to save as many lives
4467 as possible. After federal resources arrive, patients should be re-triaged based on new resource
4468 availability.

4469 For additional burn information, visit REMM's Burn Triage and Treatment of Thermal Injuries in a
4470 Radiation Emergency page.

4471



Refer To

4472 REMM's Burn Triage and Treatment of Thermal Injuries and Radiation Burns in a Radiation
4473 Emergency:

- 4474 ▪ <https://remm.hhs.gov/burns.htm>
- 4475 ▪ <https://remm.hhs.gov/cutaneoussyndrome.htm>

4476

Appendix 4.4: Triage

4477 In 2011, HHS sponsored the [Scarce Resources Project which discussed medical system issues](#)
 4478 [related to a nuclear detonation](#). The triage recommendations that resulted from this study used the
 4479 following factors ranked in the following priority, starting from the highest:

- 4480 13. Mechanical Trauma
- 4481 14. Burn injuries: based on burn depth and %TBSA
- 4482 15. Radiation dose from whole body exposure
- 4483 16. Combined injuries: radiation plus trauma and/or thermal burns
- 4484 17. Comorbid conditions: comorbid conditions that are likely to affect treatment outcomes, such as
 4485 immunosuppression, dependence on dialysis or lung injuries requiring ventilators
- 4486 [A clinical triage tool using the Scarce Resource Project guidelines](#) is available on REMM and in the
 4487 [Mobile REMM app](#). Radiation dose, mechanical injury, burn severity, and prevailing resources
 4488 adequacy are parameters in the tool.

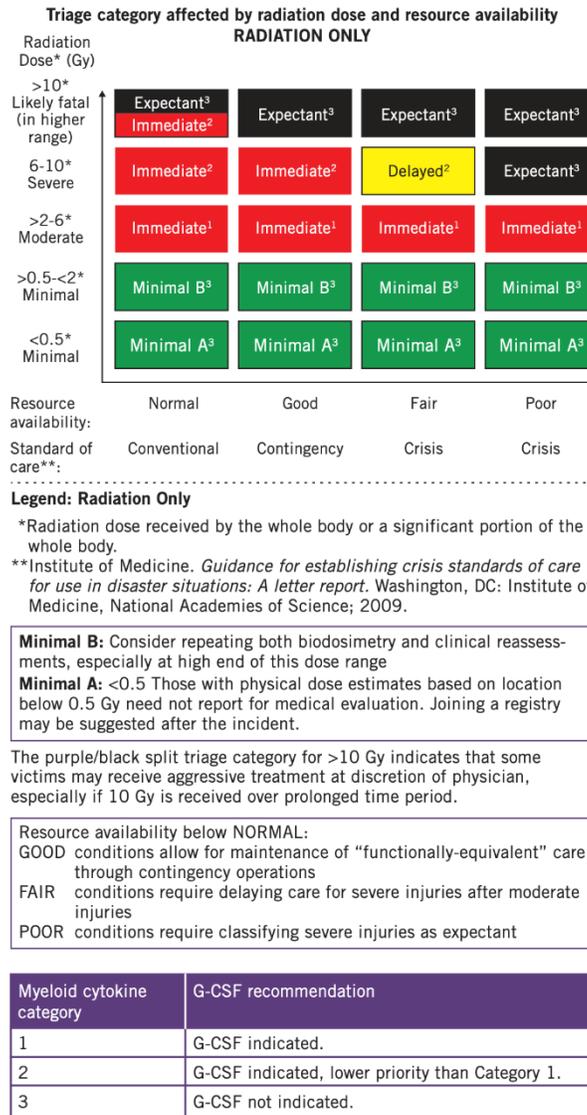
4489 Triage cards, usable by first responders or first receivers, were developed for the [Scarce Resources](#)
 4490 [Project](#). (Coleman & Knebel, 2011). The three triage cards below show examples of triage cards that
 4491 might be used following a nuclear detonation. Input parameters include assigned whole body dose
 4492 from exposure, injury type(s), and resource adequacy. Output is not only triage category but also
 4493 priority for receipt of cytokine therapy. Generally, the triage categories and the colored tags assigned
 4494 to patients associated with these systems are identical or similar to the diagram below.

| | | |
|---------------|------------------|---|
| Black | Expectant | Pain or other comfort medications only, if available, until death |
| Red | Immediate | Life-threatening injuries, seen and treated first and urgently |
| Yellow | Delayed | Non-life-threatening injuries, require care but some delay is acceptable |
| Green | Minimal | Minor injuries which will require care, but delay of hours to days may be acceptable. |

4495

4496 **Figure 42: Typical triage colors, categories, and definitions used during mass casualty**
 4497 **triage.**

Triage card 1: RADIATION ONLY—triage category affected by radiation dose and resource availability

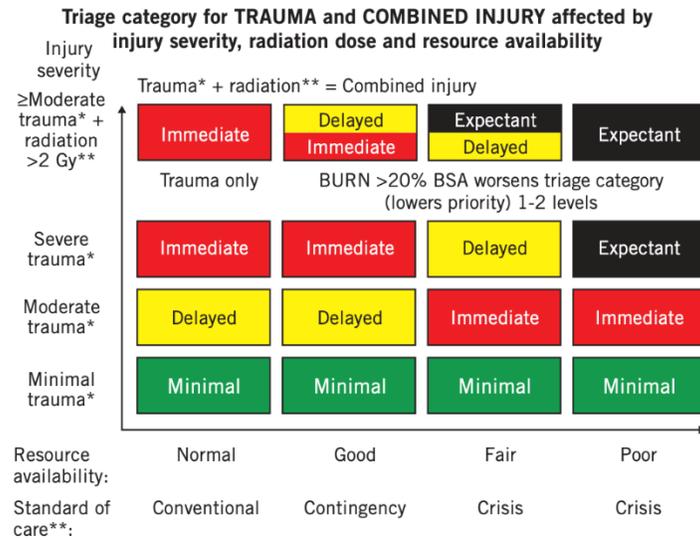


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4499

Figure 43: Triage Card 1 describes triage for radiation only patients.

Triage card 2: Triage category for TRAUMA and COMBINED INJURY affected by injury severity, radiation dose, and resource availability



Legend: Trauma and combined injury

- *Adding >20% total body surface area burn to trauma worsen triage priority by 1 category (puts them *lower on the priority list*).
- **Radiation dose received by the whole body or a significant portion of the whole body. **At higher radiation doses (>6 Gy)**, triage category may worsen—as on Combined Injury card
- ***Institute of Medicine. *Guidance for establishing crisis standards of care for use in disaster situations: A letter report*. Washington, DC: Institute of Medicine, National Academies of Science; 2009.

| Trauma category | Description |
|-----------------|--|
| Combined injury | <ul style="list-style-type: none"> • Radiation dose of >2 Gy to whole body or significant portion of whole body <i>plus moderate or severe</i> trauma and/or burn injury. |
| Severe trauma | <ul style="list-style-type: none"> • Stabilization requires complex treatment; • >20% chance of death even with treatment. |
| Moderate trauma | <ul style="list-style-type: none"> • Without stabilization, potential for death within hours • <20% chance of death with stabilization and treatment. |
| Minimal trauma | <ul style="list-style-type: none"> • Injuries pose no significant risk to life and limb in next 3-4 days • Limited or no treatment prior to referral in the next 3-4 days. |

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4501

Figure 44: Triage Card 2 describes triage for trauma and combined injury patients.

Triage cards 3 and 4: Myeloid cytokine (eg, granulocyte colony-stimulating factor) recommendation for casualties with “minimal trauma/radiation only” and “combined injury”

G-CSF priority categories for “normal or good” resource availability

| Radiation Dose* (Gy) | RADIATION ONLY or minimal trauma | | COMBINED INJURY Moderate or severe injury* + radiation** > 2 Gy | |
|------------------------|--|--|---|------------------------|
| | Minimal trauma* | | Moderate trauma* | Severe trauma* |
| >10 Gy Likely fatal | Expectant ³ Immediate ² | | Expectant ³ | Expectant ³ |
| >6-10 Gy Severe | Immediate ² | | Delayed ² | Expectant ³ |
| ≥2-6 Gy Moderate | Immediate ¹ | | Immediate ¹ | Delayed ² |

G-CSF priority categories for “fair or poor” resource availability

| Radiation Dose* (Gy) | RADIATION ONLY or minimal trauma | | COMBINED INJURY Moderate or severe injury* + radiation** > 2 Gy | |
|------------------------|-------------------------------------|------------------------|---|------------------------|
| | Minimal trauma* | | Moderate trauma* | Severe trauma* |
| >10 Gy Likely fatal | Expectant ³ | Expectant ³ | Expectant ³ | Expectant ³ |
| >6-10 Gy Severe | Delayed ² | Expectant ³ | Expectant ³ | Expectant ³ |
| ≥2-6 Gy Moderate | Immediate ¹ | Immediate ¹ | Delayed ² | Expectant ³ |

Resource Availability: Fair Poor Fair and Poor

| Myeloid cytokine category | G-CSF recommendation |
|---------------------------|--|
| 1 | G-CSF indicated. |
| 2 | G-CSF indicated, lower priority than Category 1. |
| 3 | G-CSF not indicated. |

Estimating dose from a single Absolute Lymphocyte count (ALC).
 SERIAL MEASUREMENTS MORE ACCURATE and are strongly recommended
 Using AFRRRI BAT tool on REMM is also more accurate.
Instructions: 1) Determine the ALC for that patient, 2) read down by the number of hours after the incident and 3) read across for estimate of whole body dose.
 (Table adapted by Scarce Resources Group from AFRRRI dose calculator on REMM (www.remm.nlm.gov))

| | | Absolute Lymphocyte Count (ALC) Value × 10 to the ninth (single value) | | | | | | | | | | | | |
|----------------------|----|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | | 1.3 | 1.2 | 1.1 | 1.0 | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 |
| | | Estimate of whole body dose from radiation exposure □ Below 2 Gy ■ 2-6 Gy ■ Above 6 Gy | | | | | | | | | | | | |
| Hours after exposure | 24 | 0 | 0 | 1.8 | 2.5 | 3.3 | 4.2 | 5.2 | 6.3 | 7.7 | 9.3 | >10 | >10 | >10 |
| | 48 | 0 | 0 | 0 | 1.5 | 2.0 | 2.5 | 3.1 | 3.8 | 4.6 | 5.6 | 6.9 | 8.7 | >10 |
| | 72 | 0 | 0 | 0 | 0 | 0.9 | 1.8 | 2.2 | 2.7 | 3.2 | 3.9 | 4.8 | 6.1 | 8.2 |
| | 96 | 0 | 0 | 0 | 0 | 0 | 0 | 1.7 | 2.1 | 2.5 | 3.1 | 3.8 | 4.8 | 6.5 |

4502

4503

Figure 45: Triage cards 3 and 4 describe myeloid cytokine recommendations.

4504

Appendix 4.5: Guidance Resources for Healthcare Providers, Responders, and Planners

4505

| Resource | Source | Description | Link |
|--|--|---|---|
| Radiation Emergency Assistance Center/Training Site (REAC/TS) | Oak Ridge Institute | Maintains a collection of radiation emergency medicine resources that support the medical response to radiological/nuclear incidents and the treatment of individuals injured by ionizing radiation. Includes dose estimation procedures, radiation countermeasure information, PPE guidance, and other information specifically for medical professionals. | https://orise.orau.gov/resources/reacts/index.html |
| Emergency Radiation Medicine Response Pocket Guide | Armed Forces Radiobiology Research Institute (AFRRI) | Two-page document that includes a flow chart for radiation patient treatment, a table of ARS survivability (including phases), a brief table of symptom clusters, and brief descriptions of case confirmation, treatment considerations, decontamination considerations, reporting, understanding radiation exposure, and diagnosis. | https://afri.usuhs.edu/sites/default/files/2020-07/afri-pocket-guide.pdf |
| Management of Dead Bodies after Disasters: A Field Manual for First Responders | PAHO, WHO, ICRC, IFR-CRCS ⁵⁸ | Provides practical, easy-to-follow guidelines for first responder, to promote dignified and proper management of dead bodies and facilitate their identification. | https://www.paho.org/disasters/dmdocuments/DeadBodiesFieldManual-2ndEd.pdf |

⁵⁸ Pan-American Health Organization (PAHO), World Health Organization (WHO), International Committee of the Red Cross (ICRC), International Federation of Red Cross and Red Crescent Societies (IFRCRS)

| Resource | Source | Description | Link |
|---|-------------|--|---|
| Medical Management of Radiological Casualties | AFRRI | Succinctly describes emergency biodosimetry, ARS, medical management of skin injury, medical management of internally deposited radionuclides, other injuries from nuclear weapons, psychological support, delayed effect, decontamination techniques, etc. | https://afri.usuhs.edu/sites/default/files/2020-07/4edmmrhandbook.pdf |
| Radiation Emergencies | CDC | A collection of resources tailored to various audiences, including clinicians, public health professionals, laboratorians, etc. Clinician resources focus on patient management, PPE, triage, decontamination, ARS, internal contamination, CRS, and countermeasure guidance. | https://www.cdc.gov/nceh/radiation/emergencies/index.htm?CDC_AA_refVal=https%3A%2F%2Femergency.cdc.g |
| REMM | HHS | An extensive tool for medical management during radiological incidents, REMM describes patient management, initial incident activities, management modifiers (based on injuries and medical needs), practical guidance (including use of blood products, decontamination procedures, and population monitoring), etc. Includes resources tailored to specific audiences, such as first responders, mental health professionals, hospital staff, etc. Additionally, most REMM information can be downloaded for use offline, during trainings and response. | https://remm.hhs.gov/index.html |
| Radiation Sickness | Mayo Clinic | Briefly and succinctly describes symptoms, diagnosis, and treatment of radiation sickness. | https://www.mayoclinic.org/diseases-conditions/radiation-sickness/diagnosis-treatment/drc-20377061 |

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Appendix 4.6: Response Support Teams and Planning Resources

| Resource | Source | Description | Link |
|--|--------|--|---|
| Disaster Medical Assistance Team (DMAT) | HHS | DMATs are staffed with medical professionals who provide expert patient care. DMAT team members include advanced clinicians (nurse practitioners/physician assistants), medical officers, registered nurses, respiratory therapists, paramedics, pharmacists, safety specialists, logistical specialists, information technologists, communication and administrative specialists. | https://www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/dmat.aspx |
| Disaster Mortuary Operational Response Teams (DMORT) | HHS | DMORTs provide technical assistance and consultation on fatality management and mortuary affairs. DMORTs can: <ul style="list-style-type: none"> ▪ track and document human remains and personal effects ▪ establish temporary morgue facilities ▪ assist with determination of cause and manner of death ▪ collect ante-mortem data ▪ collect victim medical records, dental records, or DNA from next of kin for victim identification ▪ perform postmortem data collection ▪ document field retrieval and morgue operations ▪ perform forensic dental pathology and anthropology operations ▪ process and re-inter disinterred remains | https://www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/dmort.aspx |

| Resource | Source | Description | Link |
|---|----------------|---|---|
| Radiation Emergency Assistance Center/Training Site (REAC/TS) | DOE | Provides emergency response and subject matter expertise on the medical management of radiation incidents. REAC/TS provides continuing medical education and outreach exercises. Additionally, the REAC/TS website describes clinical information and training opportunities. | http://orise.orau.gov/reacts |
| Radiation Injury Treatment Network(RITN) | Private Sector | Network of hospitals and medical providers with specific capabilities in treating radiation injuries. The RITN also provides training resources, adult and pediatric medical treatment recommendations, and medical referral assessment for ARS patients. | www.RITN.net |
| Victim Information Center (VIC) Team | HHS | <p>VIC teams provide technical assistance for collection and management of ante-mortem data and related issues. VIC teams can:</p> <ul style="list-style-type: none"> ▪ collect dental records, medical records, DNA, and other ante-mortem data ▪ provide subject matter expertise regarding mass fatality management and victim information procurement ▪ train partners to gather victim identification information from family interviews ▪ coordinate with FSLTT law enforcement ▪ gather ante-mortem data to facilitate victim identification ▪ manage the missing persons list ▪ update the Victim Identification Program (VIP) database ▪ coordinate the release of remains | https://www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/vic.aspx |

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4509

The tools and resources listed in this section are not all of the resources available for planners on these topics. Readers who want to learn more are encouraged to read the cited sources as well.

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4511

4512

Appendix 4.7: Resources for Medical Examiners and Coroners (ME/Cs) and Fatality Management Planning

| Resource | Source | Description | Link |
|---|---------------------------------------|---|---|
| Guidelines for Handling Decedents Contaminated with Radioactive Materials | CDC | Procedures and guidance focused on handling radioactive remains. Includes scenario-specific guidelines, addressing nuclear detonation scenarios, Radiological dispersal devices (RDD) scenario, and radioactive sources in public places. Discusses relevant instruments, protective precautions for medical examiners/coroners on-scene, morgue procedures, autopsy and funeral home guidance, transportation guidance, etc. | https://www.cdc.gov/nceh/ |
| Infectious Disease Risks from Dead Bodies Following Natural Disasters | Pan American Journal of Public Health | A review of existing literature (circa 2004) to assess the risks of infection from dead bodies following a natural disaster, including who is most at risk, what precautions should be taken, and how to safely dispose of the bodies. | https://www.scielosp.org/article/rpsp/2004.v15n5/307-312/ |
| Mass Fatality Management of Incidents Involving Weapons of Mass Destruction | DOD and DOJ | Provides information for ME/Cs to establish fatality management strategies that mutually support and integrate key agencies in response efforts. Focuses on the ME/C role, how to mobilize FSLTT resources, basic mass fatality management, handling contaminated remains, etc. | https://www.hsdl.org/?abstract&did=460809 |

| Resource | Source | Description | Link |
|--|--|--|---|
| Medical Examiner/ Coroner Guide | American Journal of Forensic Medicine and Pathology | Provides information and suggestions for decontamination procedures, specifically developed for ME/C audience. | https://pubmed.ncbi.nlm.nih.gov/19901816/ |
| Model Procedure for Medical Examiner/ Coroner on the Handling of a Body/Human Remains that are Potentially Radiologically Contaminated | Transportation Emergency Preparedness Program (TEPP) | Identifies precautions and provides guidance to ME/Cs on the handling of a body or human remains that are potentially contaminated with radioactive material from a transportation incident involving radioactive material. | https://www.hsd.org/?view&did=764068 |
| Mortuary Affairs in Joint Operations | DOD | Provides joint doctrine for mortuary affairs support in joint operations. Outlines procedures for search, recovery, evacuation (to include human remain tracking), tentative identification, processing, and/or temporary internment of remains. | http://www.fas.org/irp/doddir/dod/jp4_06.pdf |
| NCRP Report No. 161 | National Council on Radiation Protection and Measurements (NCRP) | Offers guidance on handling persons contaminated with radionuclides. | https://ncrponline.org/publications/reports/ncrp-report-161/ |
| Standard Operating Procedures for Mass Fatality Management | National Association of Medical Examiners | An SOP for mass fatality management, including detailed information about scene responsibilities, incident morgues, family assistance centers, identification, death certification, training/exercises, etc. | https://www.thename.org/assets/docs/31434c24-8be0-4d2c-942a-8afde79ec1e7.pdf |

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Appendix 5.1: Impacted Populations

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Chapter 4 provides guidance for handling patients who sustain major/critical injuries such as severe burns and trauma. Evacuating critical patients must not be hindered by lengthy or restrictive decontamination and transport policies. For those who are not critically injured, decontamination instructions vary based on response actions and available resources/assistance:

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Action Item

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Include self-decontamination instructions in public education campaigns.

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1. **Individuals who are directed to evacuate by emergency response officials** – These are individuals leaving the immediate impact zone (e.g., MDZ or LDZ zones) who may require assistance from responders to evacuate (e.g., search and rescue, emergency medical service). Some may be able to evacuate without responder assistance but as part of an organized immediate evacuation. These individuals may undergo preliminary screening at ad hoc screening locations. Emergency response officials must consult with radiation protection professionals regarding appropriate screening criteria and decontamination recommendations for these individuals that reflect the priorities and resources available.

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2. **Individuals who are not directed to evacuate by emergency response officials but choose to self-evacuate of their own volition**– This includes individuals who self-evacuate before emergency responders arrive. Once responders arrive, there may be insufficient responders to direct everyone, and people may continue to self-evacuate. Responders will be unable to provide on-scene screening and decontamination assistance before these individuals evacuate and at best may direct them to an ad hoc screening location. Ideally, public education campaigns provide self-decontamination instructions to the public prior to emergency incidents. Even then, self-decontamination instructions must be provided to the public at ad hoc screening locations, or through post-incident public outreach mechanisms. Planners should anticipate some of these individuals will be going directly to hospitals or seeking care in public shelters prior to being screened for contamination. Appendix 5.2: Strategies for Screening and Decontaminating People discusses special considerations for screening individuals arriving at shelters.

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Coordination Opportunity

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Emergency response officials must coordinate with radiation protection professionals, at the state, local, and federal levels, to develop screening criteria and decontamination recommendations. This includes state/local radiation control program staff; the Advisory Team for Environment, Food and Health; ROSS; etc.

4546 3. **Individuals who initially sheltered then evacuate as part of an organized evacuation** — It is
4547 assumed that these individuals have minimal levels of contamination upon evacuating. If feasible,
4548 public messaging should include self-decontamination instructions prior to evacuation and
4549 subsequent screening at a CRC or shelter. As in the previous category, emergency response officials
4550 must make decontamination recommendations in collaboration with radiation protection
4551 professionals and share them with CRCs and shelters.

4552 4. **Individuals in the area surrounding the detonation who have not received an evacuation notice but**
4553 **are concerned and seek screening to confirm that they have not been exposed or contaminated.**
4554 Despite being far from the impacted area, these individuals may report to hospitals or public shelters
4555 for contamination screening. This may represent a significant number of individuals, and planners
4556 must ensure they address this group's concerns. CRCs, as described in CDC's *Population Monitoring*
4557 *in Radiation Emergencies: A Guide for State and Local Public Health Planners*, address this
4558 population's needs as well as the displaced population's needs. Shelters are discussed in more detail
4559 in Chapter 4.

4560 5. **Individuals that arrive at ports of entry following an incident in a foreign country.** It is assumed
4561 that these people were not screened upon departure and will need to be screened at the port of
4562 entry. Guidance on screening this population is available at
4563 [https://www.radiationready.org/posted-tools/guidance-for-traveler-screening-at-ports-of-entry-](https://www.radiationready.org/posted-tools/guidance-for-traveler-screening-at-ports-of-entry-following-an-international-radiological-incident/)
4564 [following-an-international-radiological-incident/](https://www.radiationready.org/posted-tools/guidance-for-traveler-screening-at-ports-of-entry-following-an-international-radiological-incident/)

- 4565 ▪ Self-evacuating individuals will require decontamination instructions, through a public
4566 education campaign, or through post-event public outreach mechanisms.
- 4567 ▪ Planning must include provisions for individuals who should remain safely sheltered but
4568 begin to request contamination screening to confirm that they have not been exposed or
4569 contaminated.

4570 The public may self-evacuate using contaminated personal vehicles. Though this may result in the
4571 spread of contamination, it should not be discouraged during the initial days following a nuclear
4572 detonation. More information about this can be found in the evacuation discussion in Chapter 3.

4573 In communities where English is not the primary language, instructions should be provided in
4574 languages appropriate for the affected community. Additionally, instructions must be accessible for
4575 people with disabilities or access and functional needs. After the initial response, more detailed
4576 instructions and PAG should be provided to mitigate contamination, dose, and residual risk.



4577 **Action Item**

4578 Prepare instructions in every language spoken within your community.

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Appendix 5.2: Strategies for Screening and Decontaminating People

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1. Radiation Screening

- Screening and decontamination staff must communicate clearly and accessibly, to ensure people arriving at CRC and shelters understand the intake process and what is expected of them.
- Because of limited screening and decontamination resources, these services must be prioritized for people, followed by service animals. Resources should not be devoted to screening and decontaminating personal possessions and pets at the expense of screening and decontaminating people.
- During screening and decontamination, shelter workers must use appropriate PPE to minimize the spread of contamination.
- Additional assistance should be provided for people with disabilities, functional needs, or access needs.
- Children should not be separated from their parents.

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While this section describes screening people for radioactive contamination, people arriving at the shelter should also undergo a quick medical screening, to identify health issues that may require treatment or referral. For life-threatening or severe injuries, medical care takes priority over contamination screening and decontamination.

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If CRCs are available:

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- People who come to the shelter before going to a CRC could be directed to a CRC for initial screening and decontamination, if feasible.
- People who come to the shelter after processing through a CRC must have CRC discharge paperwork, or some other form of documentation, which can be reviewed by shelter staff to confirm appropriate screening and decontamination occurred at the CRC. If such documentation is not available, people should be re-screened and self-decontaminate upon arrival at the shelter.
- In some cases, CRCs may release people with detectable levels of contamination on their skin or clothes. These levels will not be harmful to them or others around them. However, if resources are available at the shelter, those people may clean themselves or change clothes to further reduce their levels of contamination.

4609 Appendix 5.3: Screening and 4610 Decontaminating Service Animals 4611 and Pets

4612 Experience from past disasters has shown that when people have to evacuate their homes, they
4613 most likely take their pets or service animals with them. In fact, the federal government advises pet
4614 owners against leaving pets behind if they ever have to evacuate their homes. (FEMA, 2021a)



4615 Action Item

4616 Ensure plans include provisions for handling service and companion animals.

4617 In the U.S., the number of pet dogs and cats alone exceeds 150 million (American Veterinary Medical
4618 Association, 2017). In a nuclear emergency, pets accompanying their owners present a challenge to
4619 response and relief organizations as pet evacuation, decontamination, and sheltering have to be
4620 considered along with people evacuation, decontamination, and sheltering. The Pet Evacuation and
4621 Transportation (PETS) Act of 2006 requires that state and local emergency plans address the needs
4622 of people with household pets or service animals (Public Law 109-138, 2005).

4623 A thorough cleaning of animals can present a challenge because there is no layer of clothing to take
4624 off and animals with long hair are more difficult to clean. As with people, any action to dust off and
4625 partially remove contamination is helpful. When brushing animals, care should be taken to avoid
4626 inhaling any particulates. Using a dust mask and brushing the animals outside and upwind may be
4627 appropriate. When possible, bathing and grooming thoroughly can remove additional contamination.

4628 At CRCs, areas can be designated for pet owners to clean their own animals, as this will reduce
4629 anxiety for the animals and speed up the process. To the extent possible, assistance should be
4630 provided to those unable to clean their animals themselves. For those unable to report to a CRC,
4631 instructions for cleaning pets should be provided with instructions for self-decontamination.

4632 Animals may re-contaminate themselves and bring contamination inside homes or shelters. At CRCs
4633 or public shelters, animal spaces are usually restricted. For people sheltering at home,
4634 communications should address placing pets in cages or on a leash if there is risk of re-
4635 contamination after washing. Animals cross-contaminating owners, especially children who pet them,
4636 present a health risk. Communications should also target veterinary professionals, to ensure they
4637 provide appropriate advice and services to clients whose animals may have been contaminated or
4638 received harmful levels of radiation exposure.

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Coordination Opportunity

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Incident management officials must coordinate with veterinary professionals to ensure contaminated animals are treated appropriately.

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Appendix 5.4: Handling Contaminated Vehicles

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Fallout contaminated vehicles can spread contamination outside of the damage and hazard zones. Vehicle decontamination can mitigate the spread of contamination but should not restrict or inhibit evacuations. Use of contaminated vehicles (personal or mass transit) for evacuation should not be discouraged in the initial days following a nuclear detonation, because cross-contamination issues are a secondary concern.

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1. Vehicle Contamination Screening

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The initial step of vehicle decontamination is vehicle screening, to determine the extent of contamination. If vehicles are leaving a known contaminated area (e.g., evacuating from the HZ), initial screening may be skipped in favor of immediate decontamination, assuming sufficient decontamination resources are available. Screening areas should have low levels of background radiation (less than 0.3 $\mu\text{Sv/hr}$) to ensure positive readings are attributable to the vehicles. Staging areas should be capable of containing many vehicles, to accommodate high yield nuclear detonations. In urban areas with high population density, tens of thousands of acres may be necessary to store millions of vehicles—roughly 184 vehicles per acre.

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Refer To

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Screening processes will vary, depending on resource availability. Information regarding different screening procedures can be found in the following resources:

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- [Using Preventative Radiological Nuclear Detection Equipment for Consequence Management](#) (2017)

4662

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- [Planning Guidance for Response to a Nuclear Detonation](#) (2010)

4664

- Arizona Department of Public Health’s [Radiological Emergency Response Plan](#)

4665

- [Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Contamination Avoidance](#)

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Vehicle screening requires radiation detection instruments. While, ideally, the entire vehicle should be screened, in the early phases of the evacuation responders may just screen wheel wells, vehicle grill, and interior floors. Planners should coordinate with radiological/nuclear SMEs to determine which instruments and methods to include in their plans, as well as coordinating with FSLTT organizations to determine availability.

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4672 As vehicles leave the screening and decontamination area, planners should ensure that they are not
 4673 re-screened or re-decontaminated, wasting resources needed elsewhere. Keeping a record of vehicle
 4674 screening and decontamination helps mitigate this issue. Plans must specify record keeping
 4675 practices, capturing information such as the vehicle’s VIN number, license plate number, level of
 4676 contamination on various parts of the vehicle, screening instrument used, name of person
 4677 conducting screening, and any additional decontamination instructions for the owner. An example
 4678 vehicle screening form can be seen below in Figure 46. Planners should also consider digital record-
 4679 keeping options and develop contingency plans, depending on electronic equipment availability.

Vehicle Monitoring/Decontamination Form

Date _____ Time _____ - Please Print - Private Vehicle Emergency Vehicle

Driver's Name _____ SS # □□□-□□-□□□□

Home Address _____ (Street Address) _____ (City) _____ (State) _____ (Zip)

Vehicle License Plate # _____ State _____

Vehicle Make _____ Model _____ Year _____

Mon/Decon Location _____

Vehicle Monitoring (probe window open)
Record actual meter readings

Left Side

Right Side

Front

Rear

Circle area(s) of contamination and record gross CPM readings

| Vehicle Area (Describe) | Initial Monitor | 2nd Monitor | 3rd Monitor | 4th Monitor |
|-------------------------|-----------------|-------------|-------------|-------------|
| Background | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |
| | CPM | CPM | CPM | CPM |

Type of Instrument _____

Final Action

Vehicle Decontaminated Vehicle Impounded
 Location _____

Other (Describe) _____

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Figure 46: Example vehicle screening form.

4682 2. Vehicle Decontamination

4683 If a vehicle exhibits unacceptable levels of radiological contamination (to be determined by the
 4684 authority having jurisdiction), decontamination is recommended. Wet and dry decontamination
 4685 methods are available for decontaminating the interior and exterior of vehicles.

4686 2.1. Dry Decontamination

4687 Dry decontamination with HEPA vacuums is effective on non-porous surfaces, particularly fabric and
 4688 seats in vehicle interiors. Spray-and-vacuum technologies are also available for vehicle interior
 4689 decontamination, wherein a powdery substance is sprayed throughout the vehicle (particularly in
 4690 delicate or inaccessible components), then vacuumed after about 30 minutes of absorption. These
 4691 tools may not be widely available, so planners must include access methods throughout their plans if
 4692 they intend to use them.

4693 **2.2. Wet Decontamination**

4694 Wet decontamination is more effective for non-porous surfaces and consists of applying detergent
4695 with long-handled brushes, to remove contaminated dust, mud, and debris. Additionally, spraying 60-
4696 120 psi water for 2-3 minutes can effectively decontaminate vehicle exteriors. Some advanced wet
4697 decontamination tools are available and may be more effective than water alone, but may not be
4698 readily available, so planners must include access methods in plans.

4699 Wet decontamination sometimes involves large volumes of water, so planners must consider water
4700 resource availability when determining appropriate decontamination methods. Moreover, wet
4701 decontamination methods necessitate sump systems, to collect contaminated run-off water.

4702 Vehicles that exhibit acceptable levels of radiation following decontamination should be returned to
4703 their owners, if possible, but may require long-term storage, depending on the owner's status
4704 (evacuated, injured, deceased, etc.). Vehicles that continue to exhibit unacceptable levels of
4705 contamination may be subject to additional rounds of decontamination if resources allow. At a
4706 minimum, vehicles that remain contaminated must be segregated from successfully decontaminated
4707 vehicles to prevent cross-contamination. In all cases, planners must anticipate storing potentially
4708 large numbers of decontaminated vehicles.

4709 **3. Civilian Vehicle Decontamination**

4710 Planners must coordinate with PIOs to prepare messaging that describe simple decontamination
4711 methods for civilians. Civilians may utilize their unscreened vehicles to evacuate, but a simple
4712 decontamination method, such as rinsing with soap and water, can minimize the spread of
4713 contamination.

4714 **4. Disabled Vehicles**

4715 While vehicle contamination will vary based on fallout, there will be many disabled vehicles in any
4716 nuclear detonation scenario both inside the damage zones and outside of them (e.g., resulting from
4717 accidents cause by flash blindness). Disabled vehicles will impede evacuation and response efforts
4718 by blocking ingress/egress routes, so removal operations are critical. Local governments should
4719 consider identifying, pre-qualifying, and/or pre-establishing contracts with heavy duty towing
4720 companies and storage resources.

4721 Appendix 5.5: Resources to Support 4722 Contamination Screening Activities

4723 1. Radiological Operations Support Specialists (ROSS)

4724 If there is a major incident there will be a need to supplement the existing pool of radiation
4725 professionals in impacted and surrounding communities. The ROSS, a NIMS-Typed FEMA-Certified
4726 position, was created for this purpose. ROSS are trained to assist incident management anywhere
4727 radiation protection expertise is needed. ROSS can assess the situation by interpreting data and
4728 providing actionable guidance for decision makers.

4729 ROSS are prepared for the worst NPP releases, radiological dispersal devices (RDD) or transportation
4730 accidents, as well as a nuclear detonation. They are trained to interpret radiological release models
4731 and dose projections and provide situational awareness and environmental data management using
4732 RadResponder. ROSS are also trained to deliver concise, but comprehensive guidance as required in
4733 an incident command structure, design and implement just-in-time training, and to develop and
4734 manage environmental sampling plans that meet data quality objectives. They serve their local
4735 radiation control program and emergency preparedness agency and can be requested from
4736 unaffected jurisdictions as mutual aid.

4737 2. Volunteer Radiation Professionals

4738 As stated in the National Response Framework (NRF), population decontamination activities are
4739 accomplished locally and are the responsibility of local and state authorities (FEMA, 2019b). Federal
4740 resources to assist with population monitoring and decontamination are limited and will take some
4741 time to arrive. Radiation control staff employed by local and state governments are few in number.
4742 However, other radiation protection professionals can volunteer and register with the Citizen Corps
4743 programs in their community. Specifically, the Medical Reserve Corps can recruit and train radiation
4744 professionals to assist public health and emergency management agencies with population
4745 monitoring or shelter support operations.



4746 Refer To

- 4747 ▪ Citizen Corps website: <https://www.ready.gov/citizen-corps>
- 4748 ▪ Medical Reserve Corps website: <https://www.phe.gov/mrc/Pages/default.aspx>

4749 The ESAR-VHP⁵⁹ establishes and implements guidelines and standards for registering, credentialing,
4750 and deploying medical professionals for response to large-scale national emergencies. The same
4751 system can be used to recruit and register radiological health professionals (e.g., health physicists,
4752 medical physicists, radiation protection technologists, nuclear medicine technologists, nuclear
4753 engineers, etc.) for response to nuclear emergencies. Another resource available to several states is
4754 the [Radiation Response Volunteer Corps \(RRVC\)](#), a program developed by the CRCPD with support
4755 from CDC.



Refer To

- 4757 ▪ ESAR-VHP page on the Public Health Emergency (PHE) website:
4758 <https://www.phe.gov/esarvhp/Pages/about.aspx>
- 4759 ▪ RRVC page on the CRCPD website: <https://www.crcpd.org/page/RRVC>

4760 3. Mutual Aid Programs

4761 Many states, especially those with NPPs, have established mutual aid agreements with nearby states
4762 to aid in radiation emergencies. The EMAC is a congressionally ratified organization that provides
4763 form and structure to interstate mutual aid and addresses key issues, such as liability and
4764 reimbursement. Through EMAC, a disaster impacted state can request and receive assistance from
4765 another member state quickly and efficiently.

4766 Some radiation control programs have formed compacts to provide mutual aid for radiological
4767 emergencies, such as the New England Radiological Health Protection Compact, the Mid-Atlantic
4768 States Radiation Control Compact. Consult your Radiation Control Program to find out if your state is
4769 a member of a compact.



Refer To

- 4771 EMAC website: <http://www.emacweb.org/>

4772 4. CRC SimPLER

4773 CRC SimPLER helps radiation emergency planners understand their current capacity, potential
4774 bottlenecks, and additional resource needs when planning for population monitoring during

⁵⁹ The ESAR-VHP program is administered under the Assistant Secretary for Preparedness and Response (ASPR), within the Office of Preparedness and Emergency Operations of DHHS (<https://www.phe.gov/about/aspr/Pages/default.aspx> <http://www.phe.gov/esarvhp/pages/about.aspx>)

4775 response to a radiation emergency. It focuses on typical or anticipated activities that are needed to
4776 conduct population monitoring, which include but are not limited to providing services such as: basic
4777 first aid, contamination screening, decontamination, registration, and mental health counseling. This
4778 program helps planners assess their current population monitoring capacity and plan for potential
4779 needs in a way that is simple to understand, quick to interpret, and can be taken or presented to
4780 decision makers if/when they need to ask for additional resources. This software can also be used
4781 as a training tool for locations that are beginning to form population monitoring plans and those who
4782 have not yet conducted CRC full-scale exercises. CRC SimPLER was developed using modelling
4783 software and incorporates real timing data collected from CRC exercises across the country.

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Refer To

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CRC SimPLER is available at <https://ephtracking.cdc.gov/Applications/simPler/home>

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Appendix 5.6: Available Tools for Tracking and Monitoring People

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Several electronic tools are available for planners to determine how they will track and monitor the population following a radiological incident. These tools can be used to gather and assess data, although they may require more staff and training to utilize. A brief description of these tools follows. Additional training is available for these tools.

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1. The CRC Electronic Data Collection Tool (CRC eTool)

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<https://www.cdc.gov/nceh/radiation/emergencies/crcetool.htm>

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The CRC eTool is designed to collect, analyze, visualize, and securely exchange population monitoring data, including demographics, radiation contamination measurements, radiation exposure assessment, and health outcomes. It was created using the Epi Info™ platform and can be implemented using local networks to include laptops, tablets, and cellphones. Data analysis, visualization, and transfer and exchange processes are much more efficient once data is collected electronically.

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Epi Info™ is a free platform that is commonly used by public health professionals for data collection, statistical analysis, and data visualization. It is a public domain suite of interoperable software tools designed for the global community of public health practitioners and researchers. It provides easy data entry form and database construction, a customized data entry experience, and data analyses with epidemiologic statistics, maps, and graphs for public health professionals who may lack an information technology background.

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2. Rapid Response Registry (RRR)

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<https://www.atsdr.cdc.gov/rapidresponse/#tools>

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ATSDR's RRR survey instrument gives local and state entities a tool to register responders and others exposed to or contaminated with chemical, biological, or radiological materials from a disaster. The survey instrument is a two-page form that can be distributed on paper or electronically. It can be implemented quickly to collect basic information rapidly to identify and locate victims and displaced people. Information collected by the RRR survey instrument can be used to:

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- Support real-time needs assessment during an emergency affecting public health.

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- Assess future medical assistance, health intervention, and health education needs.

- 4815 ▪ Contact enrolled individuals with information regarding exposures, adverse health impacts,
4816 health updates, available educational materials, and follow-up services.

4817 Key information to collect includes:

- 4818 ▪ Demographics (name, age, sex, home address, status, and place of employment)

- 4819 ▪ Health information

- 4820 ▪ Exposure information

- 4821 ▪ Exposure-related health effects

- 4822 ▪ Immediate health and safety needs

- 4823 ▪ Health insurance

4824 For mass casualty incidents, the four critical fields below are sufficient to establish an official registry
4825 record:

- 4826 ▪ Name

- 4827 ▪ Sex

- 4828 ▪ Address

- 4829 ▪ Contact information (telephone and email)

4830 **3. Epi CASE (Contact Assessment Symptom Exposure)** 4831 **Toolkit**

4832 <https://www.atsdr.cdc.gov/epitoolkit/index.html>

4833 The Epi CASE toolkit gives local and state public health and disaster response agencies a way to
4834 rapidly assess persons who are affected by, exposed to, or potentially exposed to CBRN or other
4835 harmful agents during incidents. The toolkit can also aid public health professionals developing a
4836 health registry. Registries are a large time and resource commitment, so careful consideration is
4837 necessary. These tools can help guide those decisions.

4838 Data collected through the toolkit can generate simple descriptive statistics. This information also
4839 can be used as for epidemiologic follow up, including health studies, community assessments,
4840 health assessments, and health registries. The Epi-CASE Toolkit is modeled after the Rapid Response
4841 Registry toolkit to help public health professionals make quick assessments.

4842 **4. The ERHMS System**

4843 <https://www.cdc.gov/niosh/erhms/>

4844 The ERHMS system is a health monitoring and surveillance framework that includes
4845 recommendations and tools to protect emergency responders during all phases of a response,
4846 including pre-deployment, deployment, and post-deployment phases. ERHMS principles apply to both
4847 small- and large-scale incidents, including local, state, and federal level responses.

4848 ERHMS supports many activities relevant to responder health monitoring:

- 4849 ▪ Identifying exposure and/or signs and symptoms early in the course of an emergency response.
- 4850 ▪ Preventing or mitigating adverse physical and psychological outcomes.
- 4851 ▪ Ensuring workers maintain their ability to respond effectively and are unharmed.
- 4852 ▪ Evaluating protective measures.
- 4853 ▪ Identifying responders for medical referral and possible enrollment in long-term health
4854 surveillance programs.

4855 ERHMS covers the following activities for each phase of deployment

4856 **4.1. Pre-deployment Phase:**

- 4857 ▪ Rostering and credentialing of emergency response and recovery workers
- 4858 ▪ Health screening for emergency responders
- 4859 ▪ Health and safety training
- 4860 ▪ Data management and information security

4861 **4.2. Deployment Phase:**

- 4862 ▪ On-site responder in-processing
- 4863 ▪ Health monitoring and surveillance during response operations
- 4864 ▪ Integration of exposure assessment, responder activity documentation, and control
- 4865 ▪ Communications of exposure and health monitoring and surveillance data during an emergency
4866 response

4867 **4.3. Post-deployment Phase:**

- 4868 ▪ Responders out-processing assessment
- 4869 ▪ Post-event tracking of emergency responder health and function
- 4870 ▪ Lessons-learned and after-action assessments

4871 Acronyms

| | | |
|------|--------|--|
| 4872 | A&W | Alert & Warning |
| 4873 | ADA | Americans with Disabilities Act |
| 4874 | AFRRI | Armed Forces Radiobiology Research Institute |
| 4875 | AGL | Above Ground Level |
| 4876 | ALARA | As Low As Reasonably Achievable |
| 4877 | AM/FM | Amplitude Modulation/Frequency Modulation |
| 4878 | AMBER | America's Missing: Broadcast Emergency Response |
| 4879 | ANSI | American National Standards Institute |
| 4880 | AOSP | Alert Origination Software Provider |
| 4881 | AOT | Alert Origination Tools |
| 4882 | ARS | Acute Radiation Syndrome |
| 4883 | ATSDR | Agency for Toxic Substances and Disease Registry |
| 4884 | AWN | Alerts, Warning, and Notifications |
| 4885 | CAP | Common Alerting Protocol |
| 4886 | CBRN | Chemical, Biological, Radiological, and Nuclear |
| 4887 | CDC | Center for Disease Control |
| 4888 | CFR | Code for Federal Regulations |
| 4889 | COG ID | Collaborative Operating Group Identification |
| 4890 | COLTs | Cell on Light Trucks |
| 4891 | COP | Common Operating Picture |
| 4892 | COWs | Cell on Wheels/Wings |
| 4893 | CPM | Counters per Minute |

| | | |
|------|---------|--|
| 4894 | CRC | Communication Reception Center |
| 4895 | CRCPD | Conference of Radiation Control Program Directors |
| 4896 | CROW | Cellular Repeater on Wheels |
| 4897 | CRS | Cutaneous Radiation Syndrome |
| 4898 | DBS | Direct Broadcast System |
| 4899 | DFZ | Dangerous Fallout Zone |
| 4900 | DHS | Department of Homeland Security |
| 4901 | DIME | Delayed, Immediate, Minimal, and Expectant |
| 4902 | DIS | Direct-Ion Storage |
| 4903 | DOC | Department of Commerce |
| 4904 | DoD | Department of Defense |
| 4905 | DOE | Department of Energy |
| 4906 | DRZ | Dangerous Radiation Zone |
| 4907 | EAS | Emergency Alert System |
| 4908 | EAST | Exposure and Symptom Triage |
| 4909 | EC | Evacuation Center |
| 4910 | EMAC | Emergency Assistance Compact |
| 4911 | EMP | Electromagnetic Pulse |
| 4912 | EMS | Emergency Medical Services |
| 4913 | EOC | Emergency Operations Center |
| 4914 | EPA | Environmental Protection Agency |
| 4915 | EPD | Electronic Personal Dosimeter |
| 4916 | EpiCASE | Epi Contact Assessment Symptom Exposure |
| 4917 | ERHMS | Emergency Responder Health Monitoring and Surveillance |

| | | |
|------|----------|---|
| 4918 | ESAR-VHP | Emergency System for Advance Registration of Volunteer Health Professionals |
| 4919 | ESF | Emergency Support Function |
| 4920 | ETN | Enhanced Telephone Notification |
| 4921 | eTool | Electronic Data Collection Tool |
| 4922 | FAOC | FEMA Alternate Operations Center |
| 4923 | FCC | Federal Communications Commission |
| 4924 | FDA | US Food and Drug Administration |
| 4925 | FEMA | Federal Emergency Management Agency |
| 4926 | FIOPs | Federal Interagency Operational Plans |
| 4927 | FMS | Federal Medical Stations |
| 4928 | FOC | FEMA Operations Center |
| 4929 | GI | Gastrointestinal |
| 4930 | GM | Geiger-Mueller |
| 4931 | GMD | Geomagnetic Disturbance |
| 4932 | GOAT | Generator On A Trailer |
| 4933 | HAN | Health Alert Network |
| 4934 | H-ARS | Hematopoietic Subsyndrome of ARS |
| 4935 | HAZMAT | Hazardous Materials |
| 4936 | HEMP | High-Altitude Electromagnetic Pulse |
| 4937 | HHS | US Department of Health and Human Services |
| 4938 | HICS | Hospital Incident Command System |
| 4939 | HOB | Height of Burst |
| 4940 | HZ | Hot Zone |
| 4941 | IAEA | International Atomic Energy Agency |

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|------|------------|---|
| 4942 | ICS | Incident Command System |
| 4943 | IMAAC | Interagency Modeling and Atmospheric Center |
| 4944 | IMAT | Incident Management Assistance Team |
| 4945 | IND | Improvised Nuclear Device |
| 4946 | IPAWS | Integrated Public Alert & Warning System |
| 4947 | IPAWS-OPEN | Integrated Public Alert and Warning System Open Platform for Emergency Networks |
| 4948 | JIC/JIS | Joint Information Center/Joint Information System |
| 4949 | kT | Kiloton |
| 4950 | LDZ | Light Damage Zone |
| 4951 | LLNL | Lawrence Livermore National Laboratory |
| 4952 | MC | Medical Center |
| 4953 | MDZ | Moderate Damage Zone |
| 4954 | MOA | Memorandum of Agreement |
| 4955 | MOU | Memorandum of Understanding |
| 4956 | NAWAS | National Warning System |
| 4957 | NCRP | National Council on Radiation Protection and Measurements |
| 4958 | NDAA | National Defense Authorization Act |
| 4959 | NECP | National Emergency Communications Plan |
| 4960 | NGO | Non-Governmental Organization |
| 4961 | NIMS | National Incident Management System |
| 4962 | NIOSH | National Institute of Occupational Safety and Health |
| 4963 | NOAA | National Oceanic and Atmospheric Administration |
| 4964 | NORAD | North American Aerospace Defense Command |
| 4965 | NPP | Nuclear Power Plant |

| | | |
|------|---------|--|
| 4966 | NPR | National Public Radio |
| 4967 | NPS | National Planning Scenario |
| 4968 | NPWS | National Public Warning System |
| 4969 | NRF | National Response Framework |
| 4970 | NRIA | Nuclear/Radiological Incident Annex |
| 4971 | NTS | Nevada Test Site |
| 4972 | NWEM | Non-Weather Emergency Messages |
| 4973 | NWR | NOAA Weather Radio |
| 4974 | OASIS | Organization for the Advancement of Structured Information Systems |
| 4975 | OSL | Optically Simulated Luminescent |
| 4976 | PAGs | Protective Action Guides |
| 4977 | PCO | President's Communications Officer |
| 4978 | PEP | Primary Entry Point |
| 4979 | PERD | Personal Emergency Radiation Detectors |
| 4980 | PETS | Pet Evacuation and Transportation Standards |
| 4981 | PIO | Public Information Officer |
| 4982 | PMO | Program Management Office |
| 4983 | PODs | Points of Dispensing |
| 4984 | PPE | Personal Protective Equipment |
| 4985 | PSAP | Public Safety Answering Points |
| 4986 | PSI | Pounds per Square Inch |
| 4987 | RDD | Radiological Dispersal Device |
| 4988 | REAC/TS | Radiation Emergency Assistance Center/Training Site |
| 4989 | REC | Regional Emergency Coordinators |

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|------|--------|---|
| 4990 | REMM | Radiation Emergency Medical Management |
| 4991 | REP | Radiological Emergency Preparedness |
| 4992 | RITN | Radiation Injury Treatment Network |
| 4993 | ROSS | Radiological Operations Support Specialist |
| 4994 | RRR | Rapid Response Registry |
| 4995 | RRVC | Radiation Response Volunteer Corps |
| 4996 | RTR | Radiation Triage, Treatment, and Transport |
| 4997 | RWT | Required Weekly Test |
| 4998 | SALT | Sort, Assess, Lifesaving Interventions, Treatment/Transport |
| 4999 | SDZ | Severe Damage Zone |
| 5000 | SECC | State Emergency Communications Committees |
| 5001 | SIP | Shelter-In-Place |
| 5002 | SLTT | State, Local, Tribal, and Territorial |
| 5003 | SMS-CB | Short Message Service—Cell Broadcast |
| 5004 | SMS-PP | Short Message Service—Point to Point |
| 5005 | SNS | Strategic National Stockpile |
| 5006 | SOP | Standard Operating Procedure |
| 5007 | SPD | Surge Protection Device |
| 5008 | SREMP | Source Region Electromagnetic Pulse |
| 5009 | START | Simple Triage and Rapid Treatment |
| 5010 | SWP | State Warning Point |
| 5011 | TBSA | Total Body Surface Area |
| 5012 | TEPP | Transportation Emergency Preparedness Program |
| 5013 | TLD | Thermoluminescent Dosimeter |

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|------|-----------|--|
| 5014 | TNT | Trinitrotoluene |
| 5015 | TRACIE | Technical Resources, Assistance Center, and Information Exchange |
| 5016 | UPS | Uninterruptable Power Supply |
| 5017 | US | United States |
| 5018 | NORTHCOMM | Northern Command |
| 5019 | VHF | Very High Frequency |
| 5020 | WEA | Wireless Emergency Alerts |
| 5021 | WHCA | White House Communication Agency |
| 5022 | XML | Extensible Markup Language |

5023 Definitions ⁶⁰

- 5024 **Adequate shelter** – Shelter that protects against acute radiation effects and significantly reduces
5025 radiation dose to occupants during an extended period. Shelters that reduce external radiation
5026 exposure by a factor of 10 or more are considered adequate.
- 5027 **ALARA (As Low As Reasonably Achievable)** – A process to control or manage radiation exposure to
5028 individuals and releases of radioactive material to the environment so that doses are as low as social,
5029 technical, economic, practical, and public welfare considerations permit.
- 5030 **Ambulatory** – Victims who are able to walk to obtain medical care.
- 5031 **Beta burn** – Beta radiation induced skin damage.
- 5032 **Blast effects** – The impacts caused by the shock wave of energy through air that is created by
5033 detonation of a nuclear device. The blast wave is a pulse of air in which the pressure increases sharply at
5034 the front and is accompanied by winds.
- 5035 **Combined injury** – Victims of the immediate effects of a nuclear detonation are likely to suffer from
5036 burns and/or physical trauma, in addition to radiation exposure.
- 5037 **Dose** – Radiation absorbed by an individual's body; general term used to denote mean absorbed dose,
5038 equivalent dose, effective dose, or effective equivalent dose, and to denote dose received or committed
5039 dose.
- 5040 **Duck and Cover** – A suggested method of personal protection against the effects of a nuclear weapon
5041 which the United States government taught to generations of school children from the early 1950s into
5042 the 1980s. The technique was supposed to protect them during an unexpected nuclear attack which,
5043 they were told, could come at any time without warning. Immediately after they saw a flash, they had to
5044 stop what they were doing and get on the ground under some cover, such as a table or against a wall, and
5045 assume the fetal position, lying face-down and covering their heads with their hands.
- 5046 **Electromagnetic Pulse (EMP)** – A sharp pulse of radiofrequency (long wavelength) electromagnetic
5047 radiation produced when an explosion occurs near the earth's surface or at high altitudes. The intense
5048 electric and magnetic fields can damage unprotected electronics and electronic equipment over a large
5049 area.
- 5050 **Emergency Management Assistance Compact (EMAC)** – A Congressionally ratified organization that
5051 provides form and structure to interstate mutual aid. Through EMAC, a disaster-affected state can

⁶⁰ When available, definitions have been adapted from Glasstone and Dolan (Glasstone & Dolan, 1977) or the Department of Homeland Security (DHS) Planning Guidance (FEMA, 2008).

5052 request and receive assistance from other member states quickly and efficiently, resolving twokey
5053 issues up front: liability and reimbursement.

5054 **Exposure Rate** – The radiation dose absorbed per unit of time. Generally, radiation doses receivedover
5055 a longer period of time are less harmful than doses received instantaneously.

5056 **Fallout** – The process or phenomenon of the descent to the earth’s surface of particles contaminatedwith
5057 radioactive material from the radioactive cloud. The term is also applied in a collective sense to the
5058 contaminated particulate matter itself.

5059 **Fission Products** – Radioactive subspecies resulting from the splitting (fission) of the nuclei of higher
5060 elements (e.g., uranium and plutonium) in a nuclear weapon or nuclear reactor.

5061 **LD50** – The amount of a radiation that kills 50% of a sample population.

5062 **Morbidity** – A diseased state or symptom, the incidence of disease, or the rate of sickness.

5063 **Mortality** – A fatal outcome or, in one word, death. Also, the number of deaths in a given time orplace or
5064 the proportion of deaths to population.

5065 **Personal Protective Equipment (PPE)** – Includes all clothing and other work accessories designed to
5066 create a barrier against hazards. Examples include safety goggles, blast shields, hard hats, hearing
5067 protectors, gloves, respirator, aprons, and work boots.

5068 **Radiation effects** – Impacts associated with the ionizing radiation (alpha, beta, gamma, neutron, etc.)
5069 produced by or from a nuclear detonation, including radiation decay.

5070 **rad** – A unit expressing the absorbed dose of ionizing radiation. Absorbed dose is the energy depositedper
5071 unit mass of matter. The units of rad and Gray are the units in the traditional and SI systems for
5072 expressing absorbed dose.

5073 1 rad = 0.01 Gray (Gy); 1 Gy = 100 rad

5074 **rem** – A unit of absorbed dose that accounts for the relative biological effectiveness of ionizing
5075 radiations in tissue (also called equivalent dose). Not all radiation produces the same biological
5076 effect, even for the same amount of absorbed dose; rem relates the absorbed dose in human tissue to
5077 the effective biological damage of the radiation. The units of rem and Sievert are the units in the
5078 traditional and SI systems for expressing equivalent dose.

5079 1 rem = Sieverts (Sv); 1 Sv = 100 rem

5080 **Roentgen (R)** – A unit of gamma or x-ray exposure in air. For the purpose of this guidance, one R of
5081 exposure is approximately equal to one rem of whole body external dose.

5082 1,000 micro-roentgen (μR) = 1 milli-roentgen (mR) 1,000 milli-roentgen (mR) = 1 Roentgen (R),
5083 thus 1,000,000 μR = 1 Roentgen (R)

5084 **Roentgen per hour (R/h)** – A unit used to express gamma or x-ray exposure in air per unit of time
5085 (exposure rate).

5086 **Shelter** – To take ‘shelter’ as used in this document means going in, or staying in, any enclosed structure
5087 to escape direct exposure to fallout. ‘Shelter’ may include the use of pre- designated facilities or
5088 locations. It also includes locations readily available at the time of need, including staying inside where
5089 you are, or going immediately indoors in any readily available structure.

5090 **Shelter-in-place** – Staying inside or going immediately indoors in the nearest yet most protective
5091 structure.

5092 **Survivable victim** – An individual that will survive the incident if a successful rescue operation is
5093 executed and will not likely survive the incident if the rescue operation does not occur.

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