



Planning Guidance for Responding to and Recovering from Radiological Dispersal Device (RDD) Incidents

After the Initial Response

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FEMA

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8 is a federal laboratory that provides testing and evaluation services and products to the national first
9 responder community. Its mission is to test, evaluate, and analyze homeland security capabilities
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13 independent technology evaluations and assessments for first responders, thereby enabling
14 informed acquisition and deployment decisions and helping to ensure that responders have the best
15 technology available to use in homeland security missions.

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Introduction

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Background

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In 2017, the Department of Homeland Security (DHS) National Urban Security Technology Laboratory (NUSTL) collaborated with the Department of Energy (DOE) National Nuclear Security Administration (NNSA) and FEMA to publish the *RDD Response Guidance: Planning for the First 100 Minutes*¹ (hereafter referred to as the *First 100 Minutes Guidance*). The *First 100 Minutes Guidance* provides emergency planners and first responders with essential information on the initial response to an explosive RDD incident. It focuses on lifesaving and incident characterization actions initiated during the immediate minutes and hours following an RDD detonation. These actions include identifying that a radiation emergency has occurred, determining the direction and extent of any radioactive material release, making initial public warnings and notifications, and delivering official guidance to keep people out of immediate harm.

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This *Planning Guidance for Responding to and Recovering from RDD Incidents: Beyond the “First 100 Minutes”* (hereafter referred to as the *RDD Response and Recovery Guidance*) picks up where the *First 100 Minutes Guidance* leaves off and provides planners with a framework for the sustained response to and recovery from an RDD incident. Many activities initiated during the initial response as described in the *First 100 Minutes Guidance* will carry forward into and/or provide the baseline for sustained response and recovery.

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This *RDD Response and Recovery Guidance*, similar to the *First 100 Minutes Guidance*, uses a timeline (in this case, the timeline is based on the “early,” “intermediate,” and “late” protective action phases established in EPA guidance²) to assist planners with identifying when certain response and recovery activities should occur post-detonation. However, planners should recognize that there will likely be no clear, distinct line of separation between these phases of the response during an actual emergency. Even the total time involved – from the RDD detonation to full recovery – may vary from months to many years, depending on specific situational factors at time of the detonation and the complexity of the response and decisions made during recovery. In essence, every RDD incident will be unique to some degree. The information presented in this guidance is designed to inform, rather than prescribe, priorities and strategies for the challenges associated with RDD incident response and recovery.

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¹ NUSTL (2017) *Radiological Dispersal Device (RDD) Response Guidance, Planning for the First 100 Minutes*. Available online at: www.dhs.gov/sites/default/files/publications/nustl_rdd-responseplanningguidance-public_28oct2021-508-revised.pdf.

² EPA (2017) *Protective Action Guide Manual, Protective Action Guides and Planning Guidance for Radiological Incidents*. EPA-400/R-17/001, PAG Manual. Available online at: www.epa.gov/sites/default/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf.

191 Purpose

192 This *RDD Response and Recovery Guidance* provides the framework needed to plan for the
193 sustained response to and recovery from an explosive RDD incident occurring anywhere within the
194 United States (U.S.), its territories, or in tribal nations.³

195 This guidance is intended as a starting point to enable emergency planners, responders, and
196 jurisdictional leaders to identify, prioritize, and implement response and recovery strategies tailored
197 to specific RDD scenarios they may face. For example, this guidance includes how to best determine
198 and select protective measures, remediation options, and incident objectives, as well as a socio-
199 economically responsible long-term recovery effort. It also is intended to help emergency planners
200 and leaders formulate timely, effective, and equitable decisions in the face of incomplete data and
201 high levels of uncertainty, as is often the case in the early phases of an incident involving radiological
202 materials and concurrent emergency response and law enforcement investigative operations.

203 Scope

204 The Strategies and Focus Areas detailed in this guidance comprise a flexible framework that
205 planners can be adapted to a wide range of potential RDD scenarios and response and recovery
206 lines of effort. This framework is intended to be adaptable to any level or size of jurisdiction or
207 geographic area – large or small, urban, or rural – that may be impacted by an RDD incident. It also
208 can serve as both a starting point for RDD incident response and recovery planning, or as a resource
209 to benchmark existing jurisdictional and/or agency specific RDD incident response and recovery
210 plans. While this guidance focuses specifically on scenarios involving explosive RDDs that produce a
211 contaminated plume, most of the Strategies and Focus Areas described herein can be adapted to
212 inform response and recovery planning for other types of radiation hazards, including non-explosive
213 RDDs or the unintentional dispersion of radioactive material.

214 This guidance augments existing national doctrine and plans for all-hazards incident response and
215 recovery, including but not limited to:

- 216 ▪ [The National Incident Management System \(NIMS\) and its Incident Command System \(ICS\);](#)
- 217 ▪ [National Response Framework \(NRF\);](#)
- 218 ▪ [National Disaster Recovery Framework \(NDRF\);](#)
- 219 ▪ [Response and Recovery Federal Interagency Operational Plan \(FIOP\);](#) and
- 220 ▪ [Nuclear Radiological Incident Annex \(NRIA\) to the Response and Recovery FIOP.](#)

³ Per the NRIA, an RDD is any device that disperses radioactive material or emits radiation by conventional explosive or other mechanical means, such as a spray, at a harmful level without a nuclear detonation occurring. The harm caused by an RDD can include radioactive contamination, increased public fear of radioactive contamination, and denial of use of the contaminated area, perhaps for many years, which would also have an economic impact and require costly remediation. An RDD that uses explosives for spreading or dispersing radioactive material is called an “explosive RDD,” sometimes also referred to as a “dirty bomb.” For an explosive RDD, the explosion adds an immediate threat to human life and property.

221 Planning guidance and best practices discussed in this document are intended to support the
222 multiple command, control and coordination structures set forth in federal statutes (e.g., the
223 Comprehensive Environmental Response, Compensation and Liability Act [CERCLA], 42 U.S.C. 9601
224 et seq.), as well as state and local laws and ordinances relative to radiological incidents).

225 This *RDD Response and Recovery Guidance* is one of many resources available in a planner's
226 toolkit. It does not provide an exhaustive account of every activity or operation that will be necessary
227 to respond to and recover from an RDD incident. Instead, it focuses on prioritizing the critical
228 activities that are either specific to the radiation hazard itself (such as characterizing contamination
229 spread) or all-hazard activities that are complicated significantly because of radiological
230 contamination (such as organizing a no-notice wide-area evacuation). Planners should use this
231 guidance as a framework and, where operational details are not provided in sufficient detail, they
232 should consult external guidance and other resources which are provided throughout this document
233 in green-colored call-out boxes per the example provided below.

234  **Recommended Resources:**

- 235 ■ *These call-out boxes, provided throughout the Focus Areas, direct planners to additional*
236 *resources they should review.*
- 237 ■ *Most often, those resources provide not just background information, but also detailed*
238 *technical guidance on how to plan for and/or execute a particular activity.*
- 239 ■ *The Focus Areas provide a high-level review of response priorities and actions. Planners*
240 *should consult the resources referenced in these green callout boxes for information on*
241 *how to fully execute the activities described.*

242 Finally, in addition to understanding best practices for recovery from radiation emergencies, planners
243 should also be familiar with general long-term disaster recovery, the components of which are
244 discussed in various Focus Area descriptions below. Planners should begin by familiarizing
245 themselves with the NDRF and other foundational guidance produced by FEMA. These resources
246 include the [Community Recovery Management Toolkit](#)⁴, which guides local governments in preparing
247 for all-hazards recovery. The resources in this toolkit are geared towards helping community leaders
248 through the long-term disaster recovery process and are intended to be useful for any phase of
249 recovery.

250 Audience

251 The primary audience for this guidance includes emergency planners, responders and leaders
252 representing a variety of multi-jurisdictional emergency management, public safety/first responder
253 (e.g., law enforcement, fire, emergency medical services and hazardous materials), environmental

⁴ See Community Recovery Management Toolkit | FEMA.gov

254 protection, engineering, public health, public works, crisis communications, disaster recovery, and
255 other organizations that plan, conduct, oversee and/or are legally responsible for RDD incident
256 response and recovery.

257 Document Organization

258 This document is organized into three (3) major sections:

- 259 ▪ **Introduction:** Provides information on document background, purpose, scope, audience, and
260 organizational structure.
- 261 ▪ **Critical Considerations and Planning Factors:** Discusses operational and protective action
262 phasing for RDD incident response and recovery, core RDD scenario considerations that
263 planners should include in their plan development, and other important factors that can
264 contribute to effective RDD preparedness planning.
- 265 ▪ **Strategies and Focus Areas:** Describes the five (5) Strategies and ten (10) supporting Focus
266 Areas that comprise the overarching framework for RDD incident response and recovery
267 presented in this document. Strategies represent high-level outcomes that the responding
268 jurisdiction(s) should be striving to accomplish throughout RDD incident response and near-term
269 recovery. Focus Areas refer to operational response activities that must be executed to achieve a
270 strategic objective.

271 Additional references, background information, and supplementary materials corresponding to
272 various key aspects of RDD incident response and recovery are provided in the annexes to this
273 document as described below:

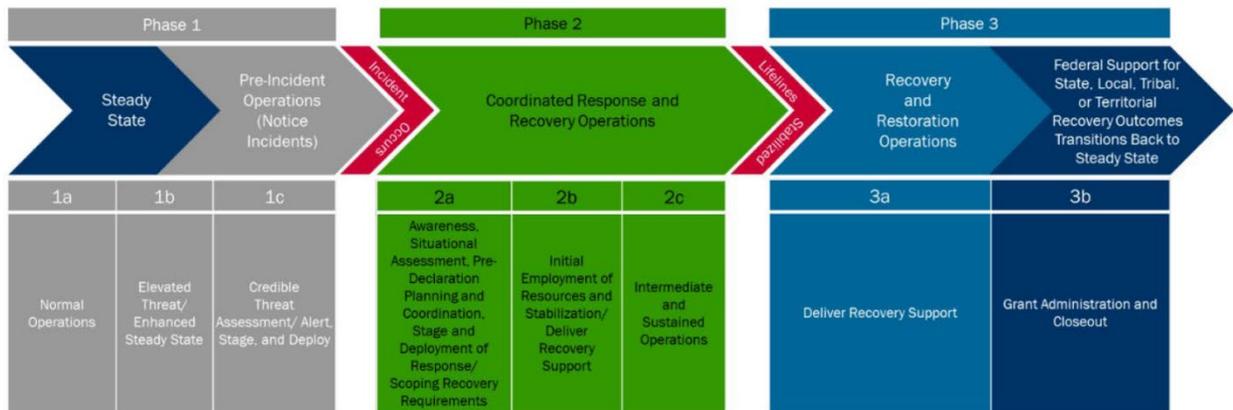
- 274 ▪ **Annex A** contains a glossary of key terms used in this document along with their corresponding
275 definitions.
- 276 ▪ **Annex B** highlights critical information and key data needs by individual Focus Area. This annex
277 includes what information needs to be collected, why it is important, and how it can inform the
278 response and recovery process. Annex B is organized based on a checklist format for ease of use
279 by planners or individuals managing RDD incident response and recovery.
- 280 ▪ **Annex C** provides a compendium of readily available radiological incident communications tools
281 and user guides, along with relevant trainings.
- 282 ▪ **Annex D** provides an overview of the key concepts, methods, and techniques for
283 decontamination and demolition of environments affected by radiological materials.
- 284 ▪ **Annex E** includes a summary of available software tools and resources that can assist planners
285 and emergency responders in managing various aspects of RDD incident response and recovery
286 (e.g., incident characterization, protective action guidance, decontamination operations, etc.).

287 Critical Considerations and Planning 288 Factors

289 This section briefly describes operational and protective action phasing for RDD incident response
290 and recovery, core RDD scenario considerations and other factors that planners should account for
291 in their plan development.

292 RDD Incident Operational Phases

293 The [DHS NRIA to the Response and Recovery FIOF](#) divides incident operations into Phase 1:Pre-
294 incident), Phase 2: (Coordinated Response and Recovery), and Phase 3:Recovery and Restoration,
295 as shown in Figure 1. The Strategies and Focus Areas described in this *RDD Incident Response and*
296 *Recovery Guidance* align with Phases 2a-c and 3a of the NRIA. This guidance does not describe
297 prevention and interdiction missions, except briefly in the context of potential additional radiological
298 or non-radiological threats following an initial RDD incident.



299
300 **Figure 1: NRIA Incident Operational Phases**

301 RDD Protective Action Phases

302 The EPA's *Protective Action Guidance (PAG) Manual*⁵ divides protective action decision making into
303 three phases that are common to all radiological incidents. These phases represent non-precise time
304 periods in which response officials would be issuing important public health protection decisions

⁵ Definitions from p. 5 in EPA (2017) *Protective Action Guide Manual, Protective Action Guides and Planning Guidance for Radiological Incidents*. EPA-400/R-17/001, PAG Manual. Available online at: www.epa.gov/sites/default/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf.

305 (e.g., shelter-in-place, evacuation, food, and water safety, etc.). Certain protective actions may
306 overlap more than one phase.

307 Protective Action phases are categorized in the EPA's *PAG Manual* as follows:

308 ▪ **Early Phase:** The period at the onset of an RDD incident when immediate decisions regarding
309 protective actions are required. Decisions in this phase are based primarily on the magnitude,
310 location, type of radioactive material involved, and the likelihood for worsening atmospheric and
311 climatic conditions. Predictions of radiological conditions based on the type of RDD (explosion or
312 other dispersal method), initial measurements of the radiation levels by first responders, and
313 weather conditions typically inform protective action guidance in this phase. In the worst case,
314 there may be little or no information available on actual releases or via field measurement data.
315 Protective actions in this phase are aimed at avoiding inhalation of gases or particulates in a
316 plume and minimizing external exposure.

317 ▪ **Intermediate Phase:** Begins after the incident source and releases have been brought under
318 control (or no longer pose a significant threat to human health) and more precise protective
319 action decisions can be made based on reliable measurements of exposure and radioactive
320 materials that have been deposited. This phase may overlap with and/or follow the early phase
321 response within as little as a few hours and can last for weeks or months. Protective actions in
322 the intermediate phase are intended to reduce or avoid radioactive exposure to the public,
323 control worker exposures and the spread of contamination, and set the stage for late-phase
324 cleanup.

325 ▪ **Late Phase:** Represents the period when actions designed to reduce radiation levels in the
326 environment to acceptable levels are conducted. This phase entails final clean-up decisions and
327 implementation of remediation strategies, and generally overlaps with the Intermediate Phase to
328 some degree. For major RDD incidents, this phase could last for years.

329 Table 1 provides a comparison of NRIA Incident Operations Phases and Protective Action Phases for
330 an RDD incident. The table demonstrates where in the NRIA incident timeline the bulk of the Focus
331 Area-specific activities described in this guidance would occur. However, it is important to recognize
332 that this timeline is notional and that some Focus Area-specific activities (e.g., evacuation and waste
333 management) may initiate earlier or extend later than what is demonstrated in Table 1 depending on
334 the situation, or some Focus Area-specific activities may be repeated iteratively over more than one
335 phase.

336 **Table 1: Comparison of NRIA Incident Operations Phases and EPA Protective Action Phases**

NRIA Incident Operations Phases:	Phase 2a 1 – 24 Hours	Phase 2b 24 – 72 Hours	Phase 2c 72 hours – 30 Days	Phase 3 30 Days+
EPA Protective Action Phases:	Early	Intermediate		Late
1 – Survey Rad Hazards	X	X	X	X
2 – Implement Rad Exposure Mitigation	X	X	X	X
3 – Communicate	X	X	X	X
4 – Conduct Phased Evacuation	X	X	X	
5 – Perform Screening and Decontamination	X	X	X	X
6 – Sustain CI		X	X	X
7 – Remediate			X	X
8 – Manage and Dispose of Waste			X	X
9 – Reopen				X
10 – Enable long-term Recovery				X

337 **RDD Incident Scenario Considerations**

338 Emergency planners should consider a number of potential scenario variations as they develop their
 339 RDD incident response and recovery plans. This scenario could include additional complicating
 340 factors depending on the mode of the threat as well as the nature of the radioactive material
 341 involved in an RDD incident. These variations, in turn, may pose a range of distinct challenges for
 342 emergency planners in terms of the timing and conduct of specific response and recovery actions,
 343 the quantity and type of resources required, strategies for communicating incident information and
 344 protective actions, managing phased evacuation and remediation actions, etc.

345 Specific factors include:

- 346 ▪ **Mode of dispersal.** An RDD could be employed either passively or actively. For example,
 347 radioactive sources or other radioactive material could be clandestinely dispersed in one or more
 348 locations. In this scenario, it may take some time to identify that an intentional release of

349 radioactive material has occurred, thus potentially complicating emergency response and
350 recovery efforts. On the other hand, an explosive RDD could be either a standalone detonation or
351 associated with an active threat situation (such as a complex, coordinated terrorist attack).
352 Additionally, one or more RDDs could be employed in conjunction with other conventional
353 explosives and non-radiological improvised explosive devices (IEDs). The presence of an active
354 threat could also complicate matters in terms of how long it takes to first determine that an RDD
355 has been employed and, second, in delays in gathering critical information needed to plan follow-
356 on emergency response and recovery efforts.

357 ▪ **Amount of material involved.** The potential harm posed by radiological material does not
358 necessarily always correlate with the amount or size of material involved. For example, one gram
359 of Cobalt-60 (Co-60) has about 1,000 times as much radioactivity and one ton of depleted
360 uranium. Rather, the activity and specific properties of the material itself determine its potential
361 harmfulness to human life. For example, a radiological source of certain materials no larger than
362 a ping pong ball could potentially be lethal at close distances. On the other hand, for longer-term
363 recovery purposes, the gross amount of material involved does matter in terms of how much may
364 be distributed across a given area. For example, a larger amount of material could potentially be
365 present in a Vehicle-borne Improvised Explosive Device (VBIED) than in a smaller device, carried
366 by hand. If actively dispersed, such as via an explosive event, a larger explosion involving a
367 greater amount of material would create a larger area of contamination than a smaller explosion
368 with a lesser amount of radioactive material. Additionally, a very large area could potentially be
369 contaminated with a low-threat material in one scenario, while a very small area could likewise
370 be contaminated with a high-threat material in another.

371 ▪ **Isotope Involved.** The specific isotope of the radioactive material used will shape planning for
372 response and recovery. Based on the type of radiation they emit – i.e., gamma, beta, or alpha
373 radiation, or a combined emitter such as Cesium-137 - radioactive materials pose threats to
374 human life in very different ways. For example, a gamma emitting source may pose a threat at a
375 distance, whereas alpha and beta emitting sources pose more of a threat when inhaled or
376 ingested. Similarly, the detectability of different materials varies by the type of radiation emitted.
377 Identifying the presence of airborne materials and the isotope involved is critical to determining
378 appropriate personal protective equipment (PPE) and detection equipment. For example, if the
379 primary radiation type is beta radiation, responders should prioritize PPE that keeps the material
380 from contacting the skin. If the material is an alpha emitter, however, which cannot hurt the skin,
381 it is more important to prioritize PPE that prevents inhalation or ingestion. Meanwhile for gamma
382 emitters, the most effective method to avoid harmful exposure will be to monitor exposure with
383 detection equipment and minimize the total time of that exposure, and if there is a risk of
384 airborne material, responders should don respiratory PPE. The differences in how these
385 radioactive materials may affect the response are summarized in Table 2. It is worth noting that
386 many isotopes emit more than one type of radiation (e.g., Americium-241 and Radium-226 emit
387 both alpha and gamma radiation, Cesium-137 and Iodine-131 emit both beta and gamma
388 radiation).

389 **Table 2: Summary of Radiation Types and How they Affect the Response**

Radiation Emitted	Harm to Humans	Ease of Detection	Example Isotopes
Gamma	Can cause harm at a distance, protective clothing largely ineffective. Respiratory PPE is critical	Easy to detect with common personal detectors	Cesium-137, Cobalt-60, Iridium-192
Beta	Most dangerous if ingested or on skin or clothes, also represents an inhalation hazard	Moderately difficult to detect, requires Geiger-Mueller (GM) detector or personal beta detection equipment	Strontium-90, tritium (Hydrogen-3)
Alpha	Only dangerous if inhaled or ingested	Difficult to detect, requires specialized equipment and potentially sample processing	Americium-241, Uranium-238, Radium-226

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- **Particle Size of the radioactive material.** The ease with which radionuclides can be dispersed into the environment has significant effects both on the response and longer-term decontamination efforts. Readily inhalable or ingestible material is likely to spread further and pose a larger risk of internal contamination and require prompt medical assessment. On the other end of the scale, ballistic fragments – that is, large chunks or pieces thrown from a detonation – will not pose any internal hazards (unless there is penetration beyond the skin surface) and will not move dramatically in wind or rain but may pose extreme external gamma or beta hazards due to the large amount of radioactive material concentrated in one place. Additionally, the geographical extent of decontamination operations will increase for certain materials that are more easily dispersed through the environment via wind, water, and mechanical means (such as fine particles being further dispersed by people walking through an affected area).
- 401
- **Solubility of the radioactive material.** The solubility of the radioactive material involved will have significant impacts on the potential for human harm, movement in the environment, and in decontamination or remediation efforts. Soluble material will absorb more readily in the lungs, or in the digestive tract, making it more important to prevent accidental inhalation or ingestion of the material by responders or the public. Containment of a soluble material will be complicated during rain or other precipitation, which may wash radioactive material into the soil, storm drains, or local waterways. This same solubility potentially makes gross decontamination easier: if contaminated water can be properly captured, most of the contamination from roads and building exteriors may be easily removed by hosing with water. Further treatment to remove fixed contamination may still be needed.
- 408
- 409
- 410

- 411 ▪ **Nature of area(s) potentially contaminated.** Emergency response and recovery efforts will be
412 complicated by the size of the area involved. Larger areas will require larger numbers of
413 resources to isolate the area, survey the hazard, conduct evacuation operations (if necessary),
414 and otherwise undertake response and recovery actions. For example, a release contained to an
415 area within a building would be less complex than a release affects multiple buildings. Likewise,
416 the type and nature of buildings, the heating and ventilation configuration, surrounding
417 geography, vegetation, and other variables will all impact the complexity of response and
418 recovery efforts.
- 419 ▪ **Number of people in the potentially affected area.** For purposes of shelter-in-place and
420 evacuation decision making, the number of people in the potentially affected area is a key
421 variable. If a release occurs in a highly populated area, more resources will be required. If a
422 release occurs in an area with a small or contained population (e.g., an industrial site), the need
423 for direct engagement in large-scale operations involving the public may be less crucial.
- 424 ▪ **Geography and weather.** One of the key factors for planners to consider is the geography of the
425 area(s) involved and the weather and climatic conditions at the time of the release. Some key
426 questions to consider: 1) Are waterways nearby? If so, containment of additional contamination
427 may become an urgent priority. For example, in urban areas, stormwater drainage and similar
428 systems are likely to capture contaminated run-off and funnel it to nearby surface waterways. 2)
429 If snow is involved, will it melt and create runoff causing further distribution of the material? 3)
430 How soon will rain occur before remediation and cleanup activities can be completed, and is it
431 likely to move materials in a way that will expand the identified hazard area? For large-area
432 contamination, it is unlikely decontamination will be completed before some type of precipitation
433 occurs. In this case, responders' early focus should be on minimizing migration instead of
434 decontamination. It is important for planners to be cognizant of the potential movement of
435 materials throughout the environment, as this movement could change the nature of the known
436 hazard area, as well as the response and recovery variables associated with the incident.

437 Other Considerations

438 Concurrent Response, Recovery, and Law Enforcement Investigative 439 Operations

440 The aftermath of an RDD incident will involve concurrent response, recovery, and law enforcement
441 investigative operations. These various activities will need to be fully coordinated via the incident
442 command structure established for the event. Additionally, it is possible that a single RDD attack
443 may represent the opening salvo in a more widespread series of follow-on threats or attacks, or that
444 secondary devices may have been placed at or near the scene or along likely routes to the scene.
445 Thus, prevention operations focused on potential follow-on threats also will need to be coordinated
446 with ongoing emergency response and recovery operations, including life-saving activities.

447 **Resources and Capability Gaps**

448 The response to an RDD incident likely will require substantial, specialized emergency response
449 resources, such as technical hazmat capabilities, beyond what is immediately available to most local
450 jurisdictions. While state and federal resources will be a critical source of support, it may take
451 several hours to days for them to become fully operational in the impacted jurisdiction. Planners
452 should account for this probability during the planning process and leverage that process to identify
453 gaps in their response and recovery capabilities. Gaps and capabilities should be mapped against
454 the external resources that likely will be provided, starting with those local, state, and federal
455 resources that are available through mutual aid, remotely, and/or on an expedited mobilization
456 timeline. For federal resources, the [NRIA](#) to the Response and Recovery FIOF is a good place to start.

457 **Remediation/Clean-Up**

458 Since an RDD has the potential to spread radioactive material over a wide area, a central part of
459 recovery from an RDD involves the remediation – or clean-up – of areas where radioactive material
460 has settled into the environment. From the remediation perspective, recovery is successful when
461 these areas can be returned to their original use (e.g., as a residence, business, or recreation
462 center), or are beneficially repurposed (e.g., a residential area re-zoned for industrial use). A
463 comprehensive RDD recovery plan must also ensure all aspects of the recovery – from public health
464 monitoring to reopening procedures to community rebuilding – allow for the continuation or
465 restoration of services critical to supporting the physical, emotional, and financial well-being of
466 impacted community members, while strengthening the key systems and resource assets that are
467 critical to the economic stability, vitality, and long-term sustainability of the communities themselves.
468 These include health and human services capabilities and networks, public and private disability
469 support and service systems, educational systems, community social networks, natural and cultural
470 resources, affordable and accessible housing, infrastructure systems, and local and regional
471 economic drivers.⁶

472 **Specialized Subject Matter Expertise**

473 Specialized technical subject matter expertise will be needed to plan, execute, and provide key
474 advice throughout the RDD incident response and recovery process. Responsible jurisdictions should
475 identify individual subject matter experts (SMEs) and operational technical working groups (TWGs)
476 comprised of multi-disciplinary SMEs who can advise incident leadership on technical aspects of the
477 response and recovery effort. Such expertise could include radiation safety professionals such as
478 health physicists and experts in radiological decontamination, as well as issue-specific experts to
479 inform key remediation strategies and techniques. Examples of SME support and other specialized
480 resources are provided in the Focus Area descriptions that follow below.

⁶ DHS (2016) *National Disaster Recovery Framework. Second Edition*. Available online at:
<https://www.fema.gov/emergency-managers/national-preparedness/frameworks/recovery>

481 TWGs can also serve as an interface between planners and responders and the wide array of federal
482 technical expertise that is available remotely and in-person. It is also possible that the affected
483 jurisdiction(s) would be best served by establishing several TWGs, which could be mobilized as
484 necessary to provide advice on specific technical aspects of the response and recovery effort (e.g.,
485 an TWG for proposing a clean-up level and another for reviewing safety plans). A critical component
486 of RDD incident planning is identifying the TWGs/SMEs available to both responsible jurisdictions
487 and external partners (e.g., state, federal, private sector, academia, etc.), and determining their role
488 and integration into the response and recovery effort.

489 **Sample of the Variety of Disciplines Required for RDD Recovery**

- 490 ▪ **Health physicist(s)** for determining occupational controls for health and safety, dose
491 calculations of people exposed to radioactive material, and supporting environmental
492 sampling plan design and execution and evaluating sampling and survey results.
- 493 ▪ **Environmental chemists** for assessing the movement of radioactive material in the
494 environment.
- 495 ▪ **Geographic information systems experts** who can map and gather diverse types of data
496 including– building type, contamination levels, critical infrastructure., etc.
- 497 ▪ **Communication specialists** who can discuss radiation risk with responders and the public.
- 498 ▪ **Food, water, and animal feed safety experts** who can help prevent the public’s ingestion of
499 radioactive material.
- 500 ▪ **Public health and medical professionals** to advise, assist, and care for the affected people
501 and animals.
- 502 ▪ **Structural engineers** who can enter contaminated areas to conduct building inspections.
- 503 ▪ **Solid waste managers** who can identify infrastructure and equipment that may be available
504 to use for the response, and to coordinate waste management activities related to the
505 response and routine waste management activities in the areas outside the hot zone (HZ).

506 **Planning Assistance**

507 Local jurisdictions should contact state agencies with core capabilities in emergency response and
508 radiological protection to initiate and coordinate emergency response and recovery planning and
509 operations. Additionally, regional representatives from federal agencies are available to assist in the
510 development of local radiological response and recovery plans.

511 **Why Plan for RDD Recovery?**

- 512 ▪ **Enable effective and efficient decontamination and remediation efforts.** Decontamination
513 and remediation involve comprehensive and inclusive engagement of public and private
514 stakeholders, which should begin as part of a comprehensive planning process. Without

515 such engagement, response and recovery will be more expensive, involve longer timelines,
516 and possibly involve loss of public trust.

517 ■ **Allow for more efficient use of resources.** RDD response and recovery will be multi-agency,
518 multi-jurisdictional, and multi-disciplinary. An effective planning process builds an
519 understanding of authorities, resources, and capabilities among various engaged partners
520 and helps identify where capacity must be built and/or filled using a combination of internal
521 and external resources.

522 ■ **Improve the safety and efficacy of response and recovery activities:** Generally speaking,
523 emergency workers, planners, and the public do not have sufficient understanding of
524 radiation hazards and related risk. Effective planning details how risk and protective action
525 information will be communicated to affected audiences.



526 **Coordination Opportunity: FEMA Office of Emerging Threats (OET)**

527 The [FEMA CBRN Office](#) and [FEMA Regional CBRN Coordinators](#) can support RDD plan
528 development. Both can be contacted via fema-cbrnoffice@fema.dhs.gov

529

530 Strategies & Focus Areas Overview

531 This *RDD Recovery Guidance* is organized into five strategies, which focus on high-level objectives
 532 that the responding jurisdiction should be striving to accomplish throughout RDD incident response
 533 and recovery. These strategies are summarized below.

- 534 ▪ **Strategy 1: Characterize, Map and Model** radiological hazards to establish the maximum extent
 535 of contamination spread, provide data for remediation activities, and determine the potential risk
 536 radiation poses to people and the environment within the contaminated area.
- 537 ▪ **Strategy 2: Communicate** radiation exposure risks to the public and first responders, to give
 538 them the information they need to protect themselves, their families, and community, enabling
 539 long-term recovery and reoccupation.
- 540 ▪ **Strategy 3: Monitor and Assist** affected populations to reduce their radiation exposure and
 541 enable continuity of disaster services amid a contaminating incident.
- 542 ▪ **Strategy 4: Restore the Environment** by reducing and removing radioactive hazards to the public,
 543 including radiological waste generated by the incident and clean-up.
- 544 ▪ **Strategy 5: Reopen and Recover** impacted areas to enable public reoccupation and re-use and
 545 equitable rehabilitation of communities.

546 Within each strategy are one or more focus areas, which describe operational response activities
 547 that must be executed to achieve the strategy objective. Focus Areas also provide information that
 548 can help a responding jurisdiction to develop/prioritize their objectives for the response. While the
 549 focus areas are numbered, they are not necessarily sequential. Each focus area contains activities
 550 that span multiple incident phases, ranging from hours and days (early phase) to months or even
 551 years (late phase) and many of the earlier activities will inform later ones. Strategies, focus areas,
 552 and activities are summarized in the Table 3 below.

553 The annexes provide supplementary material to aid the reader. Annex B highlights critical
 554 information and key data needs by focus area. It identifies what information needs to be collected,
 555 why it is important, and how it can inform the recovery process. Annex B serves as a type of major
 556 checklist for a planner or those managing an RDD recovery.

557 **Table 3: Strategies, Focus Areas, and Activities Overview**

Strategy 1: Characterize, Map, and Model		
Focus Area 1: Survey Radiological Hazards	1.1	Conduct a Wide Area Radiation Survey to Establish the Contaminated Area Boundary
	1.2	Collect Samples and Measurements for Field and Laboratory Analysis

Strategy 1: Characterize, Map, and Model		
	1.3	Conduct a Detonation Site Risk Assessment and Near-Field Grid Survey
	1.4	Implement Data Quality Practices
	1.5	Establish and Revise Incident Boundaries
	1.6	Conduct Monitoring/Surveillance to Detect Spread of Contamination
Focus Area 2: Implement Radiation Exposure Mitigation	2.1	Conduct Exposure Pathway and Dose Assessment
	2.2	Implement an Exposure/Dose Record Process for Emergency Workers, Remediation Workers, and Essential Employees
	2.3	Determine Personal Protective Equipment Requirements for the Contaminated Area
	2.4	Mitigate Spread of Contamination
Strategy 2: Communicate		
Focus Area 3: Public Communications	3.1	Provide Updated and New Early-phase Emergency Messaging
	3.2	Identify and Develop Intermediate and Late-Phase Communication Strategies
	3.3	Assess and Improve Communications
Strategy 3: Monitor and Assist		
Focus Area 4: Conduct Phased Evacuation	4.1	Identify Areas Where People Will Require Evacuation, Release from Shelter-in-Place (SIP), or an Extended Period of SIP
	4.2	Mobilize and Execute a Phased Evacuation Over the Next Few Days
	4.3	Conduct Search, Rescue, and Canvassing Operations
Focus Area 5: Screen and Decontaminate	5.1	Screen and Decontaminate Responders and their Equipment
	5.2	Consolidate Screening/Decontamination Activities and Provide Comprehensive Population Monitoring Services to the Public
	5.3	Screen and Decontaminate Personal Belongings and Civilian Vehicles Removed from Contaminated Areas
Strategy 4: Restore the Environment		
Focus Area 6: Sustain Critical Infrastructure	6.1	Gather Information on Impacted Buildings and Infrastructure
	6.2	Decontaminate Critical Infrastructure

Strategy 4: Restore the Environment		
	6.3	Establish Restoration/Sustainment Task Forces
	6.4	Conduct Restoration/Sustainment Operations
Focus Area 7: Remediate	7.1	Execute the Optimization Process for Defining Remediation Zones and Clean-up Levels
	7.2	Develop Remediation Plans
	7.3	Perform Remediation/Cleanup
	7.4	Verify Cleanup Levels
	7.5	Release the Area/Site
Focus Area 8: Manage and Dispose of Waste	8.1	Conduct Early-Phase Waste Management and Containment Operations
	8.2	Estimate the Volume of Waste and Establish Waste Management Goals
	8.3	Establish Temporary Waste Staging, Long-Term Waste Disposal Sites, and Inter-Jurisdiction Transportation Requirements
Strategy 5: Reopen & Rebuild		
Focus Area 9: Reopen	9.1	Establish Reopening Criteria for Structures in Remediation Zones
	9.2	Conduct Repairs and Prepare for Reopening
Focus Area 10: Enable Long Term Recovery	10.1	Transition from Incident Response and Lifeline Stabilization to Recovery
	10.2	Execute Existing Disaster Recovery Plans and Identify a Recovery Coordinating Structure
	10.3	Engage Stakeholders Representing Recovery Core Capability Groups
	10.4	Manage Recovery Efforts by Leveraging the Recovery Support Functions

558 Strategy 1: Characterize, Map, and 559 Model

560 Focus Area 1: Survey Radiological Hazards

561 *Guidance:* Review and complete the preliminary 10-point Monitoring Survey and begin leveraging
562 advanced radiological response assets to conduct a comprehensive survey of the contaminated
563 area. Results from the additional surveys are used to define the boundaries of contamination,
564 characterize radiological hazards, implement exposure mitigation techniques described in Focus
565 Area 2, and inform other response and recovery actions.



566 Recommended Planning Partners:

- 567 ▪ Emergency management
- 568 ▪ Fire/HAZMAT teams
- 569 ▪ Law enforcement
- 570 ▪ Public Safety Bomb Technicians / FBI Special Agent Bomb Technicians
- 571 ▪ Public health
- 572 ▪ Environmental protection
- 573 ▪ State/Local Radiation Control Program



574 Key Terminology: Hazard Control Areas

575 **The Contaminated Area:** The “contaminated area” consists of any place where radionuclides
576 are present on a surface or in the environment because of a release. A measurement baseline
577 or threshold, above which an area would be considered contaminated, should be determined
578 in advance, and then reassessed following an actual release. Identification of the
579 contaminated area will help identify areas that may require remediation and exposure
580 mitigation actions (see Focus Area 2) to protect people living or working in those areas.

581 **Hot Zone (HZ):** The Hot Zone is an area where radiation levels exceed 10 mR/h and additional
582 controls are warranted to reduce exposure to prevent long-term radiation risks.

583 **Dangerous Radiation Zone (DRZ):** The Dangerous Radiation Zone is an area where radiation
584 levels exceed 10 R/h and additional controls are warranted to reduce exposure to prevent
585 short-term radiation risks.

586 **Warm Zone:** The warm zone is a transition area between contaminated areas and
587 uncontaminated areas where responders don and doff protective gear and decontamination
588 activities take place.

589 Introduction

590 The *First 100 Minutes Guidance* outlines a 10-point monitoring survey designed to inform
591 responders of the direction and extent of contamination spread and the general scale of hazard
592 control areas (e.g., hot zone).⁷ As the 10-point survey is being completed, responders will need to
593 begin planning to conduct a more comprehensive radiological survey and hazard characterization to
594 achieve a complete picture of the radiological, chemical, and physical hazards created by the
595 incident. Through these additional surveys and characterization activities, responders should be able
596 to confirm the radionuclide(s) involved and identify the **contaminated area** boundary and radiological
597 conditions within it. This information will be essential for instituting radiation exposure mitigation
598 efforts to protect the public and responders (see Focus Area 2) and designating and prioritizing areas
599 that will require radiological remediation (see Focus Area 7).



600 Coordination Opportunity: Law Enforcement - Evidence Collection

601 The federal government will coordinate with and support SLTT authorities during incidents
602 involving nuclear/radiological weapons, materials, or devices. Federal law enforcement (e.g.,
603 Federal Bureau of Investigation [FBI]) investigative activities will be coordinated and
604 deconflicted with SLTT survey and sampling activities as well as with SLTT law enforcement
605 activities to ensure that samples collected do not interfere with the preserving and collecting of
606 evidence.

607 A comprehensive radiological measurement survey will require appropriate personnel support and
608 technical expertise. During the planning process, jurisdictions should document the advanced
609 radiological survey and analysis resources that are directly available to them as well as those
610 available through regional partners, the private sector, and the federal government. FEMA's
611 *Nuclear/Radiological Incident Annex* to the Response and Recovery FIOP includes a summary of the
612 federal assets that are available for request by a state government, some on an expedited timeline.⁸
613 Since few jurisdictions will have the resources to fully conduct all the surveys described in this focus

⁷ p.28 in NUSTL (2017) *Radiological Dispersal Device (RDD) Response Guidance, Planning for the First 100 Minutes*. Available online at: https://www.dhs.gov/sites/default/files/publications/nustl_rdd-responseplanningguidance-public_28oct2021-508-revised.pdf.

⁸ See "Appendix 1" in FEMA (2016) *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans*. Available online at: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf.

614 area, response and recovery plans should clearly document what survey requirements will be fulfilled
615 by available external assets.

616 There are four key radiological surveys that should be conducted to fully characterize an incident:

- 617 ▪ **Wide-area surveys (see Activity 1.1)** to determine with more granularity the extent of
618 contamination spread to establish hazard control area boundaries – including the HZ and DRZ –
619 as well as a general understanding of the conditions within the contaminated area.
- 620 ▪ **Field and laboratory analysis of samples (see Activity 1.2)** to determine the nuclide and the
621 chemical and physical properties of the material released (including the degree to which
622 radioactive material is loose or bound to surfaces) which will directly inform exposure mitigation
623 (see Focus Area 2) and remediation (see Focus Area 7).
- 624 ▪ **Radiological risk assessment of the release site (see Activity 1.3)** to identify short-term exposure
625 mitigation actions necessary for personnel who may need to access the site as part of the initial
626 crime scene investigation and during initial lifesaving, site stabilization and remediation
627 activities.
- 628 ▪ **Grid survey⁹ (see Activity 1.3)** to develop a detailed understanding of the conditions (e.g.,
629 distribution of contamination) within the contaminated area to provide critical data necessary to
630 initiate remediation planning.

631 Additional systematic (e.g., grid-based) surveys (before and after remediation) will be necessary in
632 the weeks and months following a radiological release as part of the remediation process. These
633 systematic surveys and their specific requirements likely will be designed and executed by private-
634 sector resources, such as the remediation contractors tasked with conducting the cleanup, rather
635 than first responders. Remediation contractors will document this information in their remediation
636 work plans (see Focus Area 7).

637 The remaining sections of this focus area describe key considerations for designating the boundary
638 of the contaminated area and developing guidance for establishing data quality objectives. The
639 **contaminated area** boundary will consist of the entire area where contamination is discovered above
640 a threshold determined during planning as the result of a release, so it will not necessarily be
641 synonymous with a hazard control area (e.g., hot zone) or the specific areas requiring remediation
642 (i.e., “remediation zones,” introduced in Focus Area 7). State and local public health officials, with
643 the support of federal expertise, will need to assess the relative hazard to the public and responders
644 in areas where contamination is discovered, as discussed in Focus Area 2. The Strategy 1 table

⁹ The “near-field” is defined in the *First 100 Minutes Guidance* as the area between the detonation site and the 1 km transect. See p. 27 in NUSTL (2017) *Radiological Dispersal Device (RDD) Response Guidance, Planning for the First 100 Minutes*. Available online at: https://www.dhs.gov/sites/default/files/publications/nustl_rdd-responseplanningguidance-public_28oct2021-508-revised.pdf.

645 found in Annex B describes the information objectives and significance of key data for making
 646 recovery decisions for this Strategy.



Recommended Resources: RadResponder

648 RadResponder is a web-based tool and iPhone/Android app managed by FEMA¹⁰ that enables
 649 organizations to rapidly and securely record, share, aggregate, and visualize radiological survey
 650 data. Users may also manage their detection instrumentation, personnel, interagency
 651 partnerships, and multijurisdictional event space. RadResponder is provided free to FSLTT
 652 responders and organizations. For more information see: <https://www.radresponder.net/>
 653 RadResponder is also available through CBRNResponder: <https://www.cbrnresponder.net/>

654 **Table 4: Summary of Focus Area 1 Activities**

	Activity	Phase
1.1	Conduct a Wide Area Radiation Survey to Establish the Contaminated Area Boundary	Early to Intermediate (Hours to Days)
1.2	Collect Samples and Measurements for Field and Laboratory Analysis	Early to Intermediate (Hours to Days)
1.3	Conduct a Release Site Radiological Risk Assessment and Grid Survey	Intermediate to Late (Days to Weeks)
1.4	Implement Data Quality Practices	Intermediate (Days to Weeks)
1.5	Establish and Revise Incident Boundaries	Intermediate to Late (Days to Months)
1.6	Conduct Monitoring/Surveillance to Detect Spread of Contamination	Intermediate to Late (Days to Months to Years)

655 **Activity 1.1: Conduct a Wide Area Radiation Survey to Establish the** 656 **Contaminated Area Boundary**

- 657 ▪ Review data from the 10-point monitoring survey, executed as part of the *First 100 Minutes*
 658 *Guidance* activities, to identify anomalies or major gaps in survey data coverage or data quality. A

¹⁰ Product of collaboration between Federal Emergency Management Agency (FEMA), Department of Energy (DOE) / National Nuclear Security Administration (NNSA), the Environmental Protection Agency (EPA), the Defense Threat Reduction Agency (DTRA), and the Department of Homeland Security's Science and Technology Directorate (DHS S&T)

659 data verification and validation process should be initiated per the *First 100 Minutes Guidance*
660 to support decision making (see Annex 4); however, it is unlikely that there will be time to
661 rigorously assess data quality until more resources are available. This review can be executed
662 remotely (e.g., using RadResponder) by a highly trained first responder, radiation safety
663 professional including a Radiological Operations Support Specialist (ROSS), emergency manager,
664 or public health official. Preliminary data should be assessed to identify:

- 665 ○ Readings that are unusually high or low relative to other nearby data points.
- 666 ○ Readings that are inconsistent with the hazard or radionuclide, if identified.
- 667 ○ Inconsistent units and/or incomplete data sets (e.g., exposure rates recorded in
668 counts per minute, not milliroentgens per hour [mR/hr]). See Activity 1.4.

669 Risk of Secondary Devices

670 Survey teams which encounter a radiological signature emanating from inside any package or
671 container in suspicious or unusual locations should assume that source could be another RDD.
672 Survey teams will immediately cease survey operations and contact a Public Safety Bomb
673 Technician/FBI Special Agent Bomb Technician.

- 674 ■ Continuously compare new survey results against revised dispersion models, such as those
675 provided by the FEMA-managed Interagency Modeling and Atmospheric Assessment Center
676 (IMAAC), which have been updated based on previous survey results. If needed, prioritize
677 completing or expanding the 10-point monitoring survey in areas where models or elevated
678 readings from outlying points indicate the potential for contamination but have not been
679 surveyed yet.
- 680 ■ Once the likely direction of contamination is established, conduct a wide-area survey to establish
681 the boundaries of the contaminated area. Table 5 provides a list of the advantages and
682 disadvantages of different wide-area survey techniques available to jurisdictions, or that may
683 become available as the response evolves. Ideally, this survey should use a combination of
684 ground and aerial techniques, executed simultaneously, leveraging state and federal resources
685 with more advanced equipment and expertise.
 - 686 ○ **Conduct an aerial survey of the areas identified as contaminated by the 10-point**
687 **survey.** An aerial survey will be especially helpful for identifying contamination on
688 rooftops and in hard-to-reach areas, and for confirming that ground surveys did not
689 miss significant pockets of contamination. Since aerial surveys are commonly taken
690 at an altitude of several hundred feet (particularly in areas with densely packed high-
691 rise buildings), their resolution is low and can only detect gamma-emitting
692 radionuclides.
 - 693 ○ **Conduct a ground survey of the areas identified as contaminated by the 10-point**
694 **survey.** Ideally, use ground vehicle-mounted detection equipment to survey the

- 695 contaminated area boundaries, as this approach will be most efficient and minimize
696 exposures. However, if ground and aerial vehicular-mounted survey resources are not
697 available and responders must take these measurements on foot:
- 698 – Measure gamma exposure rates at 1 meter (~3 feet) above ground.
 - 699 – Measure beta-gamma total surface contamination (include alpha values based
700 on radionuclides of concern).
 - 701 ○ **Refine identification of the plume centerline.** Send a radiological monitoring team to
702 the farthest point where contamination was detected, and perform transects – that
703 is, cut across the plume centerline to measure on either side - approximately every
704 kilometer, moving towards the release site;
 - 705 – Take and record gamma exposure rate measurements at 1 m (~3 ft) above
706 ground (annotate highest result and any readings ≥ 10 mR/hr (0.1 mGy/hr) (the
707 typical threshold for the hot zone)). If all values are less than or equal to 10
708 mR/hr (0.1 mGy/hr), then move to the midpoint of next transect toward the
709 release site.
 - 710 – Take beta-gamma total surface contamination measurements (include alpha
711 values based on radionuclides of concern). If the midpoint of highest values is
712 more than 250 m (820 ft) from the centerline of the initial plume estimate, adjust
713 the next transect's midpoint, as necessary.



714 Coordination Opportunity: Federal Support

- 715 ■ [Interagency Modeling and Atmospheric Assessment Center \(IMAAC\)](#): An interagency
716 coordination element responsible for production, coordination, and dissemination of
717 federal atmospheric dispersion modeling and hazard predictions for an airborne portion of
718 a hazardous material release. The IMAAC provides the single federal consensus on
719 atmospheric predictions of hazardous material concentration to all levels of the Incident
720 Command and national response organizations. Through plume modeling analysis, the
721 IMAAC provides emergency responders with predictions of hazards associated with
722 atmospheric releases to aid in the decision-making process to protect the public and
723 environment. IMAAC support can be requested directly at IMAAC@fema.dhs.gov or 703-
724 767-2003. For general inquiries or more information, email IMAAC at
725 IMAACinquiries@fema.dhs.gov.
- 726 ■ [Aerial Measuring System \(AMS\)](#), Provides rapid assessment of radioactive contamination
727 on the ground over large areas using highly sensitive detection systems mounted on fixed-
728 wing aircraft and helicopters. AMS reach back provides external aerial assets the ability to
729 collect data utilizing their own assets and have it analyzed via consistent and proven

730 methods for interpretation.¹¹ AMS is a National Nuclear Security Administration (NNSA)
731 Nuclear Emergency Support Team (NEST) asset. NNSA is a semi-autonomous agency
732 within the DOE.

- 733 ■ Airborne Spectral Photometric Environmental Collection Technology (ASPECT): Managed by
734 EPA's CBRN Consequence Management Advisory Team to provide remotely sensed
735 chemical/ radiological (gamma and neutron) data and imagery (situational awareness).
736 ASPECT can identify, quantify, and map chemical plumes and radioactive material
737 deposited on the ground. It is also capable of collecting high-resolution digital photography
738 and video products. Data products are transferred to ground base support within minutes
739 of collection through satellite communications, while in flight.¹²
- 740 ■ Regional Render Safe Teams (RRST): Led by the FBI and trained by DOE, Regional Render
741 Safe Teams are in all 56 FBI Field Offices, led by an FBI Special Agent Bomb Technician
742 and consist of Public Safety Bomb Technicians from local Public Safety Bomb Squads,
743 Regional Render Safe teams are capable of identifying, isolating, and defeating the full
744 spectrum of RDD devices. RRSTs can assist response and recovery personnel with
745 explosive hazard mitigation, isotope identification, and clearing of suspicious packages
746 during radiological surveys. While conducting RDD defeat operations, RRST can provide
747 response and recovery planners with device-specific information regarding its potential to
748 cause harm (to include effects modeling based upon observed/assessed data from the
749 actual RDD), pace of their operations and expected outcome.
- 750 ■ Radiological Assistance Program (RAP): First responder program for assessing and
751 characterizing radiological hazards from seven regional offices at DOE sites throughout the
752 U.S. Each region has a minimum of three teams with a standard composition of eight
753 personnel. Teams can be augmented with other specialists and will be tailored to the
754 specific mission. The team conducts field monitoring and sampling measurements and
755 provides radiological advice to protect the health and safety of responders and the
756 public.¹³ For more information on RAP regional offices, see:
757 <https://www.nnss.gov/pages/programs/frmac/ERAssets.html>
- 758 ■ Weapons of Mass Destruction (WMD) Civil Support Team (CST): Assess suspected WMD
759 attacks or potential CBRN incidents, advise civilian responders on appropriate actions,
760 provide expert medical and technical advice, and facilitate the arrival of additional State
761 and Federal military forces.¹⁴

¹¹ FEMA (2016) *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans*. Available online at: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf.

¹² Ibid.

¹³ Ibid.

¹⁴ Ibid.

762 **Table 5: Advantages and Disadvantages of Rapid Survey Methods Potentially Available to State,**
 763 **Local, Tribal and Territorial (SLTT) Jurisdictions**

Survey Approach	Advantages	Disadvantages
Land Vehicle Mounted	<ul style="list-style-type: none"> ▪ High-resolution survey (if GPS-labeled) ▪ Fast geographical coverage 	<ul style="list-style-type: none"> ▪ Typically, not useful as a contamination survey approach ▪ Cannot survey rooftops
Marine Vehicle Mounted	<ul style="list-style-type: none"> ▪ Survey waterfront locations (e.g., marinas, bridges) that may be difficult to reach from land 	<ul style="list-style-type: none"> ▪ Limited to surveys on water and waterfront areas and structures
Aerial Vehicle Mounted (Fixed Wing or Helicopter)	<ul style="list-style-type: none"> ▪ Rapid, wide-area survey ▪ Can easily identify hot spots missed in ground surveys ▪ Can survey hard-to-reach areas (e.g., rooftops, off-roads, areas blocked by debris or hazards) 	<ul style="list-style-type: none"> ▪ Low-resolution survey ▪ Typically, not useful as a contamination survey approach ▪ Tall buildings and inclement weather can inhibit survey
Handheld Personal Radiation Detector (PRD) Survey, Vehicle Assisted	<ul style="list-style-type: none"> ▪ High-resolution survey (if GPS-labeled) ▪ Equipment widely available ▪ Low technical expertise required 	<ul style="list-style-type: none"> ▪ Less geographical coverage per time ▪ Hard to access rooftops or areas not accessible by road ▪ Less-precise data (due to use of PRD)
Handheld Survey Meter, Vehicle Assisted	<ul style="list-style-type: none"> ▪ High-resolution survey (if GPS-labeled) ▪ Contamination survey possible ▪ Wipe/sample survey possible 	<ul style="list-style-type: none"> ▪ Less geographical coverage per time ▪ Hard to access rooftops or areas not accessible by road

764 **Activity 1.2: Collect Samples and Measurements for Field and Laboratory**
 765 **Analysis**

- 766 ▪ Identify the gamma-emitting nuclide(s) released by collecting in-situ gamma ray spectroscopy (or
 767 by collecting a reading that is less than 1 mR/h on contact and performing field gamma-ray
 768 spectroscopy of the sample) and reviewing any information that may indicate the source of the
 769 radioactive material. These details will directly inform exposure mitigation (see Focus Area 2) and
 770 remediation techniques (see Focus Area 7). These activities will primarily occur in the near field,
 771 and should accomplish the information objectives for Focus Area 1 that are described in
 772 Appendix B.
- 773 ○ Gather gamma spectroscopy, using a high purity germanium (HPGe) detector, if
 774 possible, (or other radionuclide identification device [RIID]) at several locations in
 775 which the radiation dose rate is < 500 µR/hr (5 µGy/hr), as well as a background
 776 measurement in a non-contaminated area as close to the incident area as possible.

- 777 Each sample should be 10-minutes (minimum) and the spectrometer should be
778 placed nominally 1 meter above the ground where the dose rate at 1 meter is less
779 than 1 mR/h. If an HPGe detector is not available, use a RIID to acquire the gamma-
780 ray spectrum. The spectra and dose rate information should be communicated to the
781 [Federal Radiological Monitoring and Assessment Center \(FRMAC\)](#) for additional
782 analysis and confirmation of the nuclide(s) present.
- 783 – If the CBRNResponder tool is used for data collection, consider toggling on the
784 “Share with FRMAC” setting to facilitate data sharing.
- 785 ○ If beta- or alpha-emitting radionuclides are present, obtain samples of the
786 contamination/material, conduct a field screening to determine alpha, beta, and
787 gamma radioactivity present, and send the samples to a nearby laboratory for
788 analysis and nuclide identification.
- 789 ○ If the radioactive material that was dispersed was a regulated source, such as from
790 an industrial or medical device, there may be remnants of shipping papers or
791 container markings that will indicate the nuclide(s) and activity present. This material
792 may be of evidentiary value and should be reported to the investigating agency (likely
793 the FBI); chain of custody or other specialized handling techniques may be required.
- 794 ■ Identify areas where additional samples should be collected or spot surveys should be
795 conducted to recognize or rule-out hazards that could impact other components of the response
796 (e.g., protective actions) or create cascading emergencies (e.g., drinking water contamination).
797 Typical examples include wastewater treatment plants, stormwater run-off exit points, water
798 inlets for water treatment plants, subterranean areas (underground buildings, subway systems),
799 and air intakes for buildings.
- 800 ■ Evaluate soil samples taken inside the contaminated area to determine the extent that
801 radioactive material will leach from the soil. These tests will help define the extent to which
802 ground water or storm runoff may become contaminated by contaminated soil. As these tests
803 may take a while to complete, until results are available responders should assume soil and dust
804 are both carriers of contamination either through water or through air (as resuspended dust).



Coordination Opportunity: Federal Support

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- 806 ■ EPA’s [Radiological Emergency Response Team \(RERT\)](#) provides advice on assessments of
807 dose and impact of release to public health and the environment; monitoring, sampling,
808 laboratory analyses, and data assessments to assess and characterize environmental
809 impact.
- 810 ■ EPA’s [National Center for Radiation Field Operations \(NCRFO\)](#) can provide teams support
811 for field sampling operations. NCRFO field operations include soil, vegetation, water, and
812 airborne monitoring and sampling of radioactive materials in the environment.

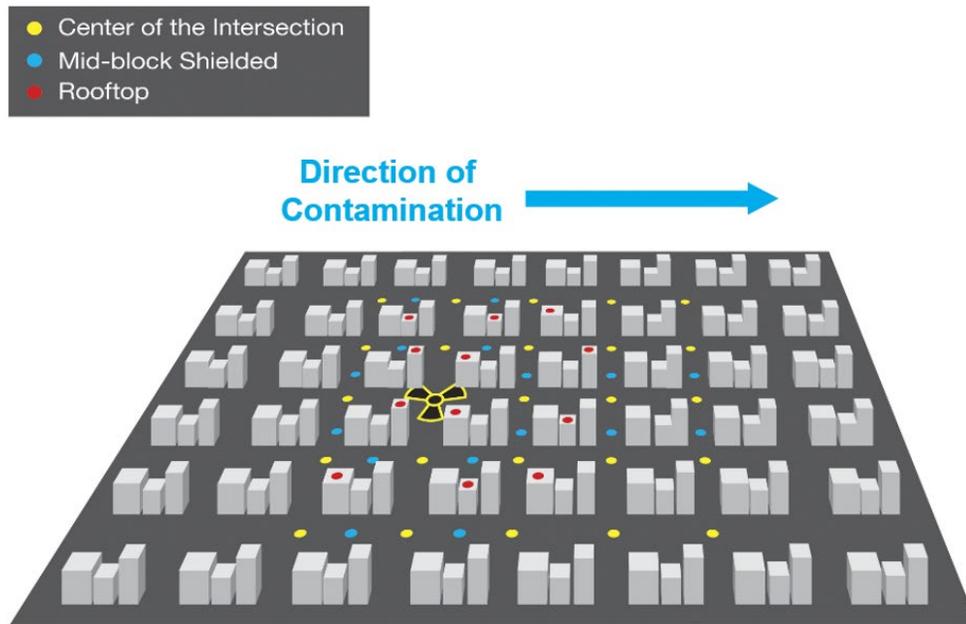
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- The EPA's [National Analytical Radiation Environmental Laboratory](#) (NAREL) can also provide support fixed laboratory testing (based out of Montgomery, AL) and, potentially, mobile laboratory testing.

816 **Activity 1.3: Conduct a Radiological Risk Assessment and Grid Survey of the**
817 **Release Site**

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- Conduct a radiological risk assessment of the release site by sending a two-person team (ideally with a vehicle to reduce exposure time) with low and high-range (>10 R/hr [>100 mGy/hr]) dose rate instruments to perform a release site¹⁵ risk assessment. This assessment is conducted to identify radiation and contamination hazards to determine if there is a need for risk mitigation (e.g., shielding, fixatives, ground cover), establish an approach for high dose rate fragment recovery, and air sampler placement. Since this survey is not a lifesaving priority, it should only be initiated once adequate worker safety protections and dose monitoring are in place.
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- Survey for exposure rate and removable contamination utilizing unmanned vehicles, extension tools, or telescoping detectors. This survey likely will need to be conducted quickly due to the high exposures in/near the release site if it cannot be performed remotely.
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- Conduct a grid survey, starting by designating a grid (see Figure 2 for an example in an urban environment) to enable the conduct of systematic surveys of the contaminated area. The grid initially should be focused on the near-field area, as described by the *First 100 Minutes Guidance*, but may need to be expanded further to obtain an understanding of the dose rates and level of contamination throughout the contaminated area. This grid survey should be conducted by radiation safety professionals and responders with experience in conducting radiological surveys. Since this survey is not a lifesaving priority, it should only be initiated once adequate worker safety protections and dose monitoring are in place.
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- Note: The purpose of the near field survey conducted as part of the *First 100 Minutes Guidance* (Tactic 8) is to rapidly identify the initial Hot Zone boundary and general radiological conditions. The purpose of this grid survey is to provide a detailed understanding of the conditions (e.g., distribution of contamination) within the contaminated area to initiate remediation planning.

¹⁵ The “detonation site” is defined in the *First 100 Minutes Guidance* as the immediate area surrounding the detonation, extending out to 20 m. Note: This site may be larger if dose rates exceed 10 R/hr (0.1 Gy/hr). See p.47 in *Radiological Dispersal Device (RDD) Response Guidance, Planning for the First 100 Minutes*. Non-explosive RDDs may not involve a detonation, so ‘release site’ is used here to address a wider range of threats.

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- Initially extend the grid approximately 250 m (~820 ft) around the release site and 1 km in the direction of contamination towards the transect identified in the 10- point monitoring survey.
- 845
- Perform radiation exposure rate surveys every 50-100 m (165-330 ft) when possible or, at a minimum, at intersections and the mid-block. At each measurement location, measure the following:
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- Gamma exposure rate at 1 m (~3 ft) from the ground, with ion chamber or energy compensated Geiger Mueller (GM) detector preferred (e.g., units in mR/hr)
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- Beta-Gamma total surface contamination (include alpha values if appropriate), preferably with 100-square-centimeter probes (e.g., dpm/100 cm²)
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- If resources permit, consider obtaining rooftop radiation dose rate measurements and at street corners and mid-block where possible. Rooftop measurements will help determine the amount of material released but will be less critical for informing health and safety decisions during the early and intermediate phases of the response.
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Figure 2: Notional Grid-based Survey Strategy¹⁶

¹⁶ Stephen Musolino, Frederick T. Harper, Brooke Buddemeier, Michael Brown, and Schlueck. (2013) "Updated Emergency Response Guidance for the First 48 Hours after the Outdoor Detonation of an Explosive Radiological Dispersal Device." *Health Physics*, vol. 105 no.1: 65-73. Available online at: <https://doi.org/10.1097/HP.0b013e31828a8fb1>.



Coordination Opportunity: Law Enforcement - Technical Support

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- Law enforcement and counterterrorism operations will be taking place as the risk assessment process is underway. FBI Special Agent Bomb Technicians lead the Field Office's responses to all improvised explosive devices, suspicious packages, and weapons of mass destruction (WMD) devices. Additionally, they lead the Field Office's Regional Render Safe Team in conducting WMD device defeat and mitigation actions for WMD devices and materials, while also serving as a point of contact for public safety bomb squad coordination¹⁷. Radiological survey personnel who encounter a suspicious package must immediately cease operations and contact an FBI Special Agent Bomb Technician or a Public Safety Bomb Squad/Technician. Only FBI Special Agent Bomb Technicians, supported by DOE, may evaluate the threat of a known or suspected RDD.

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- The FBI has a WMD Coordinator assigned to each of its field offices. Among other things, WMD Coordinators are responsible for the FBI's WMD investigative and countermeasures program and may serve as the point of contact for emergency responders and public health at the state and local level in the event of a threat or incident potentially involving a WMD.

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- The FBI Evidence Response Team Unit (ERTU): The Hazardous Evidence Response Team (HERT) provides training, leadership, and subject matter expertise in hazardous evidence collection, as well as in the management and processing of forensic evidence in CBRN crime scenes. ERTU also provides coordination and oversight for operational response and activities of FBI field office HERTs.

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Activity 1.4: Implement Data Quality Practices

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- Initiate the data assessment process, which is part of the data lifecycle throughout all phases of emergency response and recovery. This process involves (1) reviewing the objectives of data collection; (2) gathering new, current, or historical data (e.g., aggregate survey data); (3) data verification and validation (V&V) and flagging potential issues; and (4) assessing data quality.

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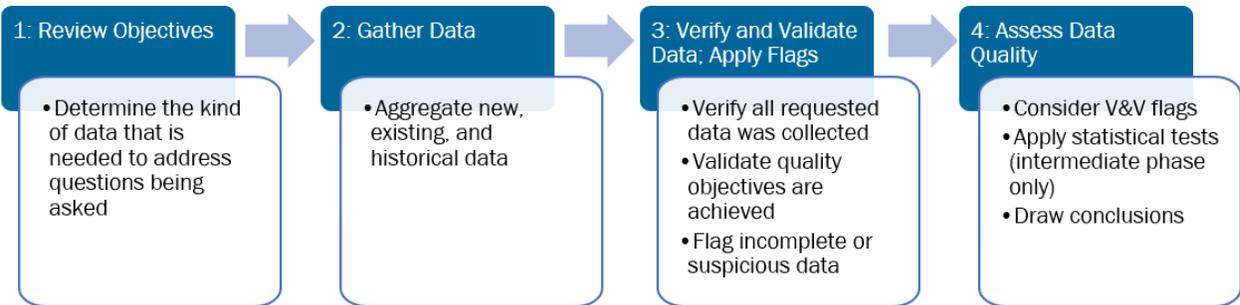
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- As discussed in the *First 100 Minutes Guidance*, first responders may not have time to rigorously assess data during the initial response phase since decisions will need to be made quickly to protect the public, responders, and the environment. However, as the response progresses, and more resources become available, incomplete, or suspicious data will need to be reconciled through a data assessment process that includes V&V of data. This process will help decision-makers avoid drawing false conclusions and basing important and costly decisions on incomplete or incorrect

¹⁷ FEMA (2016) *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans*. Available online at: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf.

892 data. Applying data quality practices adds confidence and defensibility to the data
893 that inform decisions (e.g., determining the contaminated area, shelter versus
894 evacuation).

- 895 ○ Figure 3 provides a high-level, condensed overview of the major steps of the data
896 assessment process. Planners should refer to the Radiological Data Assessment
897 Guidance for Emergency Response for an in-depth introduction to Data Quality
898 Assessment (DQA).¹⁸



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Figure 3: Data Assessment Process (Condensed Overview)

- 901 ■ Review the objectives of data collection: Determine the type of data that needs to be collected to
902 answer the questions that are asked. For example, these data could be data to support a
903 decision (e.g., shelter-in-place or evacuate) or data to estimate what the dose rate is in a
904 particular area. The objective will inform what information is requested for each measurement.
905 For example, for the objective of determining whether radioactive contamination is present,
906 multiple measurements will be required along with the measurement value and units, the
907 location, the background radiation level at the location of interest, and the time and day of the
908 measurement, among other things.

- 909 ■ Gather new, current, and/or historical data (i.e., aggregate data):

- 910 ○ An immediate challenge to conducting data assessment is that a considerable
911 volume of data will be collected and, if that data is hand-written or manually recorded
912 on individual spreadsheets, the process for reviewing data will be cumbersome and
913 inefficient. First responders can mitigate this challenge by using software platforms
914 tailored specifically for radiological data collection, sharing, and mapping, such as
915 CBRNResponder.¹⁹ Using CBRNResponder will enable response organizations to

¹⁸ DOE (2022) *Radiological Data Assessment Guidance for Emergency Response*. Available online at:
<https://www.cbrnresponder.net/app/index#resources/documents/download/2308>.

¹⁹ Information about using RadResponder during RDD incident responses, along with information regarding evaluating, validating, and analyzing data is also available in the *First 100 Minutes Guidance*, Annex 5.

916 create a common operating picture and begin verification and validation (V&V) of
917 radiological data.

918 ○ Ideally, each contamination and dose rate measurement should have the information
919 identified in the callout box below to the extent it is available. If responders are using
920 CBRNResponder, much of this information can be pre-populated before an incident
921 occurs or auto-populated when a measurement is recorded. While some of these
922 data may not be available early in the response, emergency responders should take
923 steps as early as possible to ensure all appropriate information is collected for each
924 measurement as the response unfolds. Radiation experts will use this data to assess
925 measurements collected and plan future data collection objectives.

Information for Radiological Emergency Response and Recovery Data

Data collected during radiological emergency response and recovery operations should ideally record the following information. If not, all information is available, as much information as possible should be collected to enable an effective data quality review.

- 930 ▪ **Measurement units**
- 931 ▪ **Background measurement and any background adjustments**
- 932 ▪ **Full name, agency-affiliation, and contact information of individuals performing the**
933 **measurement.** This information is critical to enable follow-up and to answer questions.
934 Information such as instrument brand and model number, for example, can be collected
935 later if necessary.
- 936 ▪ **Instrument or measurement type (e.g., Pancake probe, smear sample).** Instrument brands
937 and model numbers (e.g., Ludlum 2360 w. 43-93 alpha-beta, 100cm² probe). Calibration
938 information for each instrument (including nuclide efficiencies for contamination
939 instruments). This information is critical to fully assessing the quality of data collected but
940 may be collected later if not immediately available.
- 941 ▪ **Date, time, and description (e.g., distance above ground for a dose-rate, sample area) of**
942 **measurement.** Global Positioning System (GPS) coordinates for measurement location

- 943 ▪ Initiate V&V of data and apply flags.
 - 944 ○ Verification: Assess if all the requested data for the objective was collected (e.g.,
945 information fields in the blue box above).

- 946 ○ Validation: Assess if the measurement quality objectives were achieved for each
947 measurement. Like verification, measurement results are compared to a list of
948 quality objectives (e.g., precision, accuracy, representativeness, completeness)?²⁰
- 949 ○ Apply V&V flags: If a measurement does not satisfy V&V requirements, a data
950 assessor may apply a “flag” to the measurement (or the flag may automatically be
951 applied in CBRNResponder) to indicate the particular issue, such as suspicious or
952 incomplete information.
- 953 – If information about a measurement is missing, but that information (e.g., name
954 or agency) has no influence on the public protection or safety objective currently
955 being addressed, the data assessor may choose not to apply a flag.
- 956 ■ Quality Assessment: Determine if the available information will/could be used to address the
957 data collection objective and what conclusions can be drawn. Use the results of the V&V steps
958 and consider all flags to determine if the data can be used as is and draw conclusions with the
959 information available, or if follow up is needed to fill in information gaps prior to drawing any
960 conclusions. This step may involve statistical tests to determine confidence levels and false
961 negative and positive error rates.



962 Coordination Opportunity: Federal Support

963 Consequence Management Home Team (CMHT): Provides analytical and operational support
964 to DOE’s Nuclear Emergency Support Team (NEST), which includes the analysis and
965 interpretation of the initial release based on early data. The CMHT also provides map products,
966 coordination of laboratory assets, and situational awareness of response teams deployed to an
967 incident and can be accessed remotely at all times to support radiological data analysis.



968 Recommended Resources: DOE’s Radiological Data Assessment Guidance

969 DOE (2022) *Radiological Data Assessment Guidance for Emergency Response*. Available
970 online at: <https://www.cbrnresponder.net/app/index#resources/documents/download/2308>.

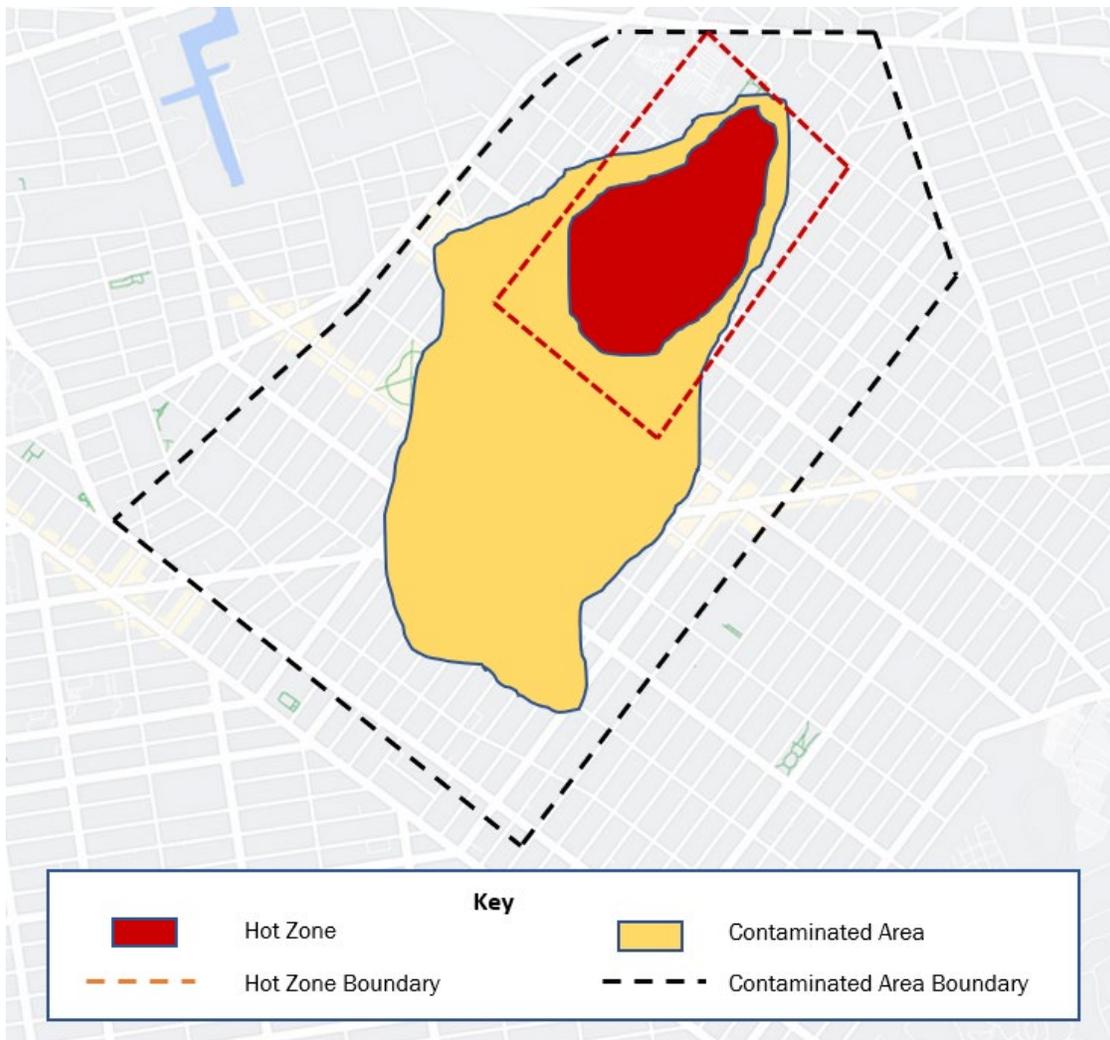
971 Activity 1.5: Establish and Revise Incident Boundaries

- 972 ■ Adjust boundaries for hazard zones identified during the preliminary 10-Point Monitoring Survey,
973 such as DRZs, HZs, and warm zones, as well as the crime zone perimeter, if appropriate.

²⁰ For more information about precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) parameters, refer to the DOE (2022) *Radiological Data Assessment Guidance for Emergency Response*. Available online at: <https://www.cbrnresponder.net/app/index#resources/documents/download/2308>.

- 974 Continue mapping and physically marking hot spots or ballistic debris. Should explosive hazards
975 remain, coordinate with Public Safety Bomb Technicians/FBI Special Agent Bomb Technician
- 976 ■ Define and map boundaries for the contaminated area. These boundaries will determine public
977 access limitations, responder protective actions, and will serve as a starting point for identifying
978 remediation zones (see Focus Area 7). Boundaries should be drawn by taking into consideration
979 two factors:
- 980 ○ The location and nature of radiological hazards in the area: the actual extent and
981 magnitude of contamination levels, determined through the wide-area and grid-based
982 surveys, and whether the contamination source is fixed, removable, or a combination
983 of both, will determine where boundaries are drawn. This consideration may also
984 incorporate exposure pathway analysis conducted in Focus Area 2.
- 985 ○ Physical, geographical, or geopolitical boundaries: pre-existing organizational units
986 (e.g., municipal borders or township lines) and physical features of the incident area
987 topography (e.g., buildings, structures, streets, intersections, utilities) may be helpful
988 for defining boundaries where preventing physical access to an area is required.
- 989 ■ Establish perimeter access controls to the contaminated area. Access points will likely be the
990 checkpoints identified in Focus Area 4.
- 991 ○ The perimeter of the contaminated area may be considerably larger than the safety
992 perimeter that was established during initial response operations as described in the
993 *First 100 Minutes Guidance* to control access to the hot zone. (see Figure 4 below).
994 Initially, use law enforcement personnel to secure access, but prepare to transition to
995 longer-term perimeter control that reduces the first responder personnel footprint
996 (e.g., physical barriers, alarming sensors, cameras, signage, private security, and
997 existing terrain to prevent unauthorized access to these areas). Access to the
998 designated crime scene area within the contaminated area will need additional
999 coordination with law enforcement.
- 1000 ○ Review your local legal authorities for access control. Not all jurisdictions have legal
1001 authority to exclude access to an area and, depending on the release site and
1002 material, federal authorities, such as a National Defense Area (NDA) or National
1003 Security Area (NSA), may or may not apply.²¹

²¹ FEMA (2016) *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans*. Available online at: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf.



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Figure 4: Example map showing a notional hot zone and contaminated area as well as boundaries selected to make communicating and managing of boundaries easier.

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Activity 1.6: Conduct Monitoring/Surveillance to Detect Spread of Contamination

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- If airborne radioactivity (such as a contaminating plume) is detected, acquire, and deploy static continuous air monitor (CAM) samplers near the boundary of the contaminated area and other work areas. These should be networked into a remote detection system to monitor migration of radioactive material throughout the area.

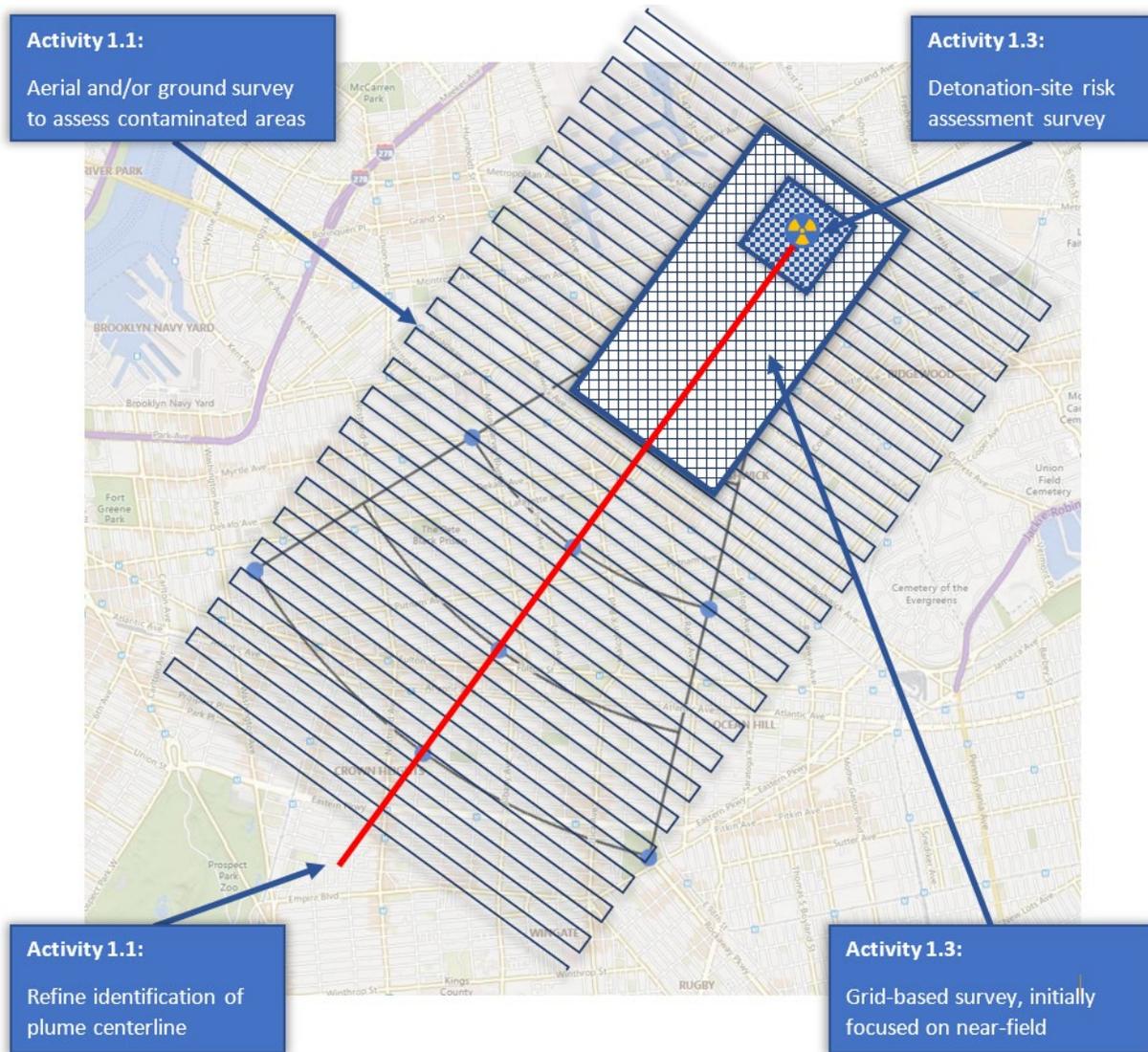
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- Conduct periodic re-surveys (daily, if possible) of contaminated area boundaries to detect the spread of contamination or change in radioactivity over time due to changing environmental conditions (e.g., rain and wind), radioactive decay, and/or human activity (e.g., during evacuation or remediation). The contaminated area boundary may change as a result of these activities.

- 1017 ○ As people, vehicles, or equipment entering and leaving the contaminated area are
1018 likely to spread contamination, the boundaries of the contaminated area need to be
1019 controlled and monitored to prevent inadvertent spread (see the *First 100 Minutes*
1020 *Guidance* Tactic 7 for more information on securing the scene). Decontamination
1021 activities will similarly need to be controlled and monitored to prevent runoff or other
1022 decontamination waste from spreading material outside the defined boundary.
- 1023 ○ Note that vehicle traffic, especially heavy vehicles such as dump trucks or bulldozers,
1024 operating in contaminated areas may disturb settled radioactive material, creating
1025 secondary dust plumes, which could represent an inhalation hazard. Remediation
1026 activities in contaminated areas should be accompanied by additional boundary
1027 monitoring to ensure radioactive material does not escape the established boundary.
- 1028 ■ Monitor waterways close to but outside of the contaminated area to confirm they are not
1029 contaminated above an action level. Samples collected from waterways are most important if the
1030 radionuclide is soluble but should be collected for all incidents. For urban areas, storm runoff
1031 drainage outlets and wastewater treatment plants should be monitored as well. For rural areas,
1032 this monitoring should include both drinking water wells and groundwater, though contamination
1033 may not appear in these samples for a long time – potentially years - after the incident,
1034 depending on the local geology. Early sample collection of drinking water from wells and
1035 groundwater will provide information on naturally occurring material in the water to improve
1036 assessments later.
- 1037 ■ While agricultural contamination may be unlikely for RDD incidents, local agricultural activities
1038 should be monitored for radioactivity as well, particularly if airborne contamination was present
1039 or local waterways were contaminated. This monitoring program will help prevent disruption of
1040 agricultural activities or concern over the safety of those products.
- 1041 ○ Leverage the exposure pathway analysis conducted as part of Focus Area 2 activities
1042 to determine if there is an ingestion pathway risk for agricultural products in the
1043 areas where contamination settled or is projected to spread over time.
- 1044 – If there is ingestion risk for agricultural products, the appropriate Derived
1045 Response Levels (DRLs) can be calculated by the FRMAC. These DRLs can then
1046 be used by responders to determine which products may not be safe for
1047 consumption. If there is concern that food and/or water will continue to be
1048 significantly contaminated beyond the first year, the long-term circumstances
1049 need to be evaluated to determine whether the recommended DRLs or other
1050 guidance would be most appropriate.
- 1051 ○ The State Radiation Control Program may be consulted as part of this effort.
1052 Additionally, the Advisory Team for Environment, Food, and Health (A-Team) is a
1053 federal radiological emergency response asset that is available through the FRMAC
1054 to provide recommendations on protective actions to minimize contamination of milk,

1055 food, and water; disposition of contaminated livestock, poultry, and food; and health
1056 and safety advice for the public.

- 1057 ○ The Food Emergency Response Network (FERN) utilizes a network of food-testing
1058 laboratories at the local, state, and federal levels to support a response to biological,
1059 chemical, or radiological contamination of food. Federal partners include Health and
1060 Human Services (Food and Drug Administration, Centers for Disease Control and
1061 Prevention), U.S. Department of Agriculture, U.S. Customs and Border Protection,
1062 Department of Defense, FBI, EPA, and DHS.



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Figure 5: Summary of surveys discussed in Focus Area 1

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Recommended Resources:

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- Conference of Radiation Control Program Director (2006) *Handbook for Responding to a Radiological Dispersal Device: First Responders Guide – The First 12 Hours*. Available online at: <https://www.crcpd.org/resource/resmgr/docs/rdd/rdd-handbook-forweb.pdf>

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- Musolino, Stephen, Frederick T. Harper, Brooke Buddemeier, Michael Brown, and Richard Schlueck. (2013) “*Updated Emergency Response Guidance for the First 48 Hours after the Outdoor Detonation of an Explosive Radiological Dispersal Device.*” *Health Physics*. Vol.105 no.1: 65-73. Available online at: <https://doi.org/10.1097/HP.0b013e31828a8fb1>

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- DHS (2012) *Key Planning Factors for Recovery from a Radiological Terrorism Incident*. Available online at: <https://www.hsdl.org/?abstract&did=756119>

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- FEMA (2016) *Nuclear/Radiological Incident Annex (NRIA) to the Response and Recovery Federal Interagency Operational Plans (FIOPs)*. Available online at: https://www.fema.gov/sites/default/files/documents/fema_incident-annex_nuclear-radiological.pdf

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- EPA (2017) *PAG Manual: Protective Action Guidance and Planning for Radiological Incidents*. Available online at: <https://www.epa.gov/radiation/protective-action-guides-pags>

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1083 Focus Area 2: Implement Radiation Exposure Mitigation

1084 **Guidance:** Assess exposure pathways and conduct dose assessments to determine the potential
1085 health risks for the public and responders in contaminated areas. Develop and implement exposure
1086 mitigation actions.



1087 Recommended Planning Partners:

- 1088 ▪ Emergency management
- 1089 ▪ Fire/HAZMAT teams
- 1090 ▪ Law enforcement
- 1091 ▪ Public health
- 1092 ▪ Radiation protection
- 1093 ▪ Radiation safety/safety officers
- 1094 ▪ Occupational health and safety
- 1095 ▪ Environmental protection

1096 Introduction

1097 Focus Area 2 is underpinned by two overarching objectives:

- 1098 ▪ Identify the exposure pathways and conduct dose assessments for people in contaminated areas
1099 and determine exposure mitigation controls to protect the public and response personnel, inform
1100 phased evacuation operations (Focus Area 4), and set the basis for the Optimization Process for
1101 remediation operations (Focus Area 7).
- 1102 ▪ Implement radiation exposure mitigation (reduction) activities, such as preventing contamination
1103 spread and minimizing public health risks, identifying PPE requirements (type and quantity), and
1104 establishing a dose monitoring and tracking system for responders and various categories of
1105 emergency and recovery workers.

1106 Responding to a radiological emergency will expose emergency workers²² and recovery workers to a
1107 variety of hazards, including radiation and radioactive contamination. Because of this exposure, an
1108 immediate priority during any RDD response is to identify and deploy to the scene qualified safety
1109 officers who also have sufficient knowledge and experience in radiation safety to weigh the
1110 radiological risks and other risks that are present against the work taking place. The term “Radiation

²² NCRP Report No. 179: *Guidance for Emergency Response Dosimetry* discusses the definition of emergency workers and how that term differs from other workers.

1111 Health and Safety Officer (RHSO)²³ has been suggested as a term for this type of personnel, since
1112 the term “Radiation Safety Officer (RSO)”²⁴ has a specific regulatory definition that applies only to
1113 radioactive materials licensees. The term RHSO is used in this guidance to communicate when a
1114 safety officer (SO) should have radiation protection expertise; the term RSO is used specifically in
1115 situations where radioactive materials licensees are involved, such as the contractors who conduct
1116 radioactive remediation operations (Focus Area 7).

1117 The complexity of the tasks expected to be performed within this focus area, along with the number
1118 and type of personnel required to execute them, will vary with the size, type, and nature of the
1119 incident. For smaller-scale RDD incidents, key tasks may be performed with personnel available from
1120 local and state public health and other relevant agencies, supported by a radiation health and safety
1121 officer. For larger-scale incidents requiring the coordination and support of a larger number of
1122 agencies and technical contractors, alignment of these tasks, as well as the distributed nature of the
1123 work required to perform ongoing assessment operations, will entail substantial planning and
1124 coordination across agencies and additional radiological subject matter expertise.

1125 During the initial phases of the response to the incident and for small-scale events, hazardous
1126 materials teams with personnel trained and equipped to deal with radiological hazards should be
1127 able to perform the minimum essential tasks with assistance from public health radiation safety
1128 officials. Depending on the size and scale of the incident, the quantity and type of radiation detection
1129 and monitoring equipment (such as personal radiation dosimeters) available may immediately
1130 become critical limiting factors impacting responder and worker health and safety.

1131 The threat posed by radiological materials released or distributed into the environment in an RDD
1132 incident will vary over time based on factors such as radioactive decay and movement of
1133 contamination through the environment. See the [RDD Incident Scenario Considerations](#) section for
1134 more information.

1135 It is important for planners to consider that the dose assessment and monitoring processes which
1136 begin with the radiological release will continue over an extended period of time, perhaps lasting
1137 years if not decades. Responder health registries from the World Trade Center attacks in 2001, for
1138 example, are still active today.²⁵ The initial priorities set and actions taken for this monitoring
1139 process during the early phase of the response will transition to more structured and widely
1140 coordinated efforts over the following weeks and months. Planners should consider a
1141 comprehensive dosimetry program as part of pre-incident planning to ensure their local jurisdiction is
1142 prepared to capture and warehouse dosimetry data both to inform response and recovery activities
1143 and provide long-term records to facilitate health and wellness follow-up for responders and the
1144 general public. Without adequate pre-incident planning, the dosimetry data management process

²³ See the *Field Guide for Health and Safety Officers: Radiological Incidents*, NYC Dept. of Health and Mental Hygiene, 2014. <https://remm.hhs.gov/fieldguide.htm>

²⁴ The term “radiation safety officer” has a specific, regulatory definition provided in 10 CFR 35.2.

²⁵ CDC (2023) 9.11 *World Trade Center Health Program*. Available online at: <https://www.cdc.gov/wtc/>

1145 (including the who, what, when, and where exposure has occurred) likely will be vague or uncertain
1146 and ultimately impact the effectiveness of response and recovery operations.



Recommended Resources: Data Collection Templates

1148 While not designed for responders, emergency response registry tools developed by the Agency
1149 for Toxic Substances and Disease Registry (ATSDR) and the CDC can serve as templates for
1150 data collection for responders.

- 1151 ▪ ATSDR Rapid Response Registry: <https://www.atsdr.cdc.gov/rapidresponse/>
- 1152 ▪ CDC Community Reception Center Electronic Data Collection Tool (CRC eTool):
1153 <https://www.cdc.gov/nceh/radiation/emergencies/crcetool.htm>
- 1154 ▪ CDC Epi CASE Toolkit <https://www.atsdr.cdc.gov/epitoolkit/index.html>

1155 EXPOSURE MITIGATION OVERVIEW

1156 Exposure mitigation (reduction) starts with the application of “as low as reasonably achievable”
1157 (ALARA)²⁶ radiation safety principles and is based on minimizing radiation doses while limiting the
1158 release of radioactive materials into the environment by employing all “reasonable methods.” ALARA
1159 is not only a sound safety principle, but also a regulatory requirement for all radiation protection
1160 programs. Implementing ALARA can help prevent unnecessary exposure and limit accidental
1161 overexposure.

1162 Applying the ALARA principle involves three essential factors that can help limit external, whole-body
1163 radiation exposure: **time**, **distance**, and **shielding**. These three factors are familiar to most first
1164 responders trained to deal with radiological contamination as well as other hazardous materials.



Key Terminology: Time, Distance, and Shielding

1166 **Time:** Minimizing exposure time to radioactive sources reduces the radiation dose received.

1167 **Distance:** Increasing the distance from the radiation source lowers exposure. Radiation
1168 exposure decreases by a factor of four when the distance is doubled and by a factor of nine if
1169 the distance is tripled.

1170 **Shielding:** Lead or lead-equivalent shielding for gamma rays can effectively reduce radiation
1171 exposure.

²⁶ In the 2017 EPA Protective Action Guides (PAG), ALARA is defined as “making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which the activity is undertaken.”

1172 In addition to time, distance, and shielding considerations, other mitigation techniques may include
1173 using proper PPE (e.g., disposable contamination control clothing, gloves, safety glasses, and
1174 respirators) to reduce the risk of ingestion, absorption, and inhalation of radioactive material.
1175 Similarly, covering the released material (shielding) or fixing it in place may prevent further spread of
1176 the material. Most common techniques for reducing exposure—such as using lead bricks to block
1177 external radiation (shielding) or limiting time spent in the contaminated area—will not mitigate the
1178 risk of internal exposure due to inhalation of particulates, which may occur in the context of a smoke-
1179 producing RDD or a release in which the disturbance of deposited material causes resuspension of
1180 radioactive dust.

1181 **RADIATION HEALTH AND SAFETY PLAN (R-HASP)**

1182 Many of the activities that comprise this focus area should be incorporated into a dedicated
1183 Radiation Health and Safety Plan (R-HASP) or radiation-focused supplement to the HASP for
1184 emergency workers, remediation workers, and essential employees. The R-HASP is a technical
1185 document that outlines many different safety factors and procedures for personnel working in or
1186 near a radioactive hazard. An R-HASP typically includes a discussion of radiological hazards and an
1187 analysis of risks to human health and safety, an organizational structure for safety operations,
1188 requirements for safety training, and an exposure control and monitoring program.

1189 It is also important to remember that radiation is only one hazard that may be encountered during
1190 the response and recovery to an RDD, so radiation safety, along with other occupational health and
1191 safety programs, should follow the appropriate hierarchy of controls.

1192 Whenever possible, an R-HASP template should be developed beforehand and then adapted to
1193 incident-specific radiation hazards and work activities required once an incident occurs. At a
1194 minimum, it should be reviewed by and coordinated with the Incident Commander, Radiation
1195 Technical Working Group (R-TWG), and/or applicable regulatory agencies (e.g., state/local health
1196 departments and labor/occupational health departments). R-HASP implementation should be
1197 overseen by RHSOs if possible and adhered to by anyone entering the contaminated area. While an
1198 R-HASP will help protect workers, each agency and employer holds the ultimate responsibility for
1199 ensuring the health and safety of their own workers.

1200 **Recommended Resources: Field Guide for Health and Safety Officers**

1201 The “[Field Guide for Health and Safety Officers: Radiological Incidents](#)” guidance issued by the
1202 New York City Department of Health and Mental Hygiene is available in the Radiation
1203 Emergency Medical Management (REMM) site as an example resource. This document can be
1204 utilized as an expedient resource for personnel functioning in the radiation health and safety
1205 officer role in the initial phases of an RDD incident. The Field Guide includes useful information
1206 and templates for safety briefings, dose assessment, and other important safety activities.

1207 Additional site-specific R-HASPs or HASP supplements should be developed to cover other types of
 1208 personnel, including contracted workers, accessing the site for specific purposes like conducting
 1209 remediation operations. These supplemental plans should be consistent with the approach and
 1210 processes detailed in the overall incident HASP, as supplemental plans typically are limited to the
 1211 internal procedures, equipment, and training specific to particular groups with access to a
 1212 contaminated site (e.g., a specific contractor organization). Information collected by safety personnel
 1213 under safety plan requirements are also a part of recordkeeping for long-term health surveillance
 1214 purposes.

1215 **Table 6: Summary of Focus Area 2 Activities**

	Activity	Phase
2.1	Conduct Exposure Pathway and Dose Assessment	Early to Intermediate (Hours to Days)
2.2	Implement an Exposure/Dose Record Process for Emergency Workers, Remediation Workers, and Essential Employees	Early to Intermediate (Hours to Days)
2.3	Determine Personal Protective Equipment Requirements for the Contaminated Area	Early to Late (Hours to Weeks)
2.4	Mitigate Spread of Contamination	Intermediate to Late (Days to Years)

1216 **Activity 2.1: Conduct Exposure Pathway and Dose Assessment**

- 1217
- 1218 ■ **Identify groups** of people who may be at higher risk of radiation exposure (such as those who are
 1219 pregnant, immunocompromised, etc.) and who will require an exposure pathway assessment,
 1220 starting with the groups identified in Table 8 below. Further tailor pathway and dose assessment
 to special at-risk groups (e.g., children or pregnant people).

 - 1221 ■ **Conduct an exposure pathway analysis** to assess the routes by which radiation or radioactive
 1222 materials can reach humans and cause exposure, resulting in radiation dose. The exposure
 1223 assessment process should be detailed in the HASP; it should also be used to determine
 1224 protective action guidance for the public in terms of limiting further exposures. It is important to
 1225 assess both retrospective (past) and prospective (current/future) exposure pathways. Pathway
 1226 assessments should consider:
 - 1227 ○ The exposure pathways described in Table 7 below. Principal exposure pathways
 1228 include ingestion, inhalation, and direct (external) exposure. An assessment of these
 1229 pathways is used to estimate the total radiation exposure that would result in a dose
 1230 that a person will receive from both external and internal sources. Dose can then be
 1231 used to determine the risk – or probability – of injury, disease, or death from such
 1232 exposure.

- 1233 ○ The specific properties of radionuclides, such as the energy emissions, half-lives,
 1234 retention in the body, physical and chemical form, etc. The radionuclide identification
 1235 conducted through the monitoring and sampling activities in Focus Area 1 will inform
 1236 this part of the dose assessment. For example, if the radionuclide released is a
 1237 gamma emitter (e.g., Cs-137), the exposure pathways of primary concern will be
 1238 external exposure; however, for an alpha emitter (e.g., Am-241), internal and
 1239 ingestion pathways would be the primary pathways of concern (see Table 2 in Critical
 1240 Considerations and Anticipated Challenges above).

1241 **Table 7: Exposure Pathways in the Early vs Intermediate/Late Phases**

Exposure Pathway	Early Phase	Intermediate/Late Phases
Inhalation of radioactive materials in the plume	Yes	No
Direct exposure from radioactive materials in the plume (immersion)	Yes	No
Inhalation of ground-deposited radionuclides resuspended into the breathing zone	Yes	Yes
Direct exposure from “groundshine” from deposited radioactive material	Yes	Yes
Ingestion of contaminated food and drinking water	Yes*	Yes

*Unintentional ingestion of contaminated food and water may occur during the early phase if people are unaware of the release of radioactive material (such as might occur during an undetected or slow-to detect release) or if protective actions were not issued regarding the safety of food and water supplies in and around the impacted area.

1242

1243

Table 8: Categorization of Groups of People for Exposure Pathway and Dose Assessments

Group	Description
Emergency Workers	<p>Emergency workers are individuals (e.g., firefighters, police officers, public health, EMS, public health workers, emergency managers, etc.) who respond to the scene of the incident and/or are involved in the field activities described in the <i>First 100 Minutes Guidance</i>. Hospital-based “first receivers” and responders supporting decontamination activities also fall into this category. Due to the type of work performed, this group may have the highest risk for exposure to radiation and is a priority for retrospective dose assessment. Finally, the emergency worker category may also include government personnel who conduct short-term mitigation activities, such as cleaning surfaces or handling radioactive material, in furtherance of extended stabilization of the contaminated site. The nature of the exposure for this group should decrease once the scene is stabilized and longer-term response and recovery operational planning begins.</p>
Essential Employees	<p>This category consists of essential workers assigned specific roles and responsibilities within critical facilities located within a contaminated area, or those who may encounter contamination through execution of their regular duties. This could include workers who provide essential functions for the community (e.g., utility workers, building maintenance, safety and security, and key continuity of operations personnel), transit workers assisting with evacuation of potentially contaminated populations to CRCs or other locations, and sanitation workers at facilities outside the contaminated area (e.g., wastewater treatment plants). Usually, workers categorized within this group are not assigned radiological remediation tasks as part of their normal job responsibilities. Although their risk and exposure during an RDD incident will be significantly lower than that of remediation workers, they may be considered “radiological workers,” and subject to the corresponding occupational dose limits and radiation worker safety and awareness training requirements. They also likely will need to be part of a dosimetry and PPE management program to enable monitoring of their external exposure while working in contaminated areas.</p>
Remediation Workers	<p>Personnel tasked to conduct remediation clean-up activities in the later phases of the incident. Such personnel enter contaminated areas and work with equipment and machinery to reduce the amount of radioactivity present. Remediation workers will require significant radiation safety and other hazmat training. From a regulatory standpoint, such personnel would likely be covered under 29 CFR 1910.1096 and, thus, occupational dose limits would apply, in addition to any other relevant regulatory restrictions or guidance. Exposure/dose assessments for this group are not necessary until at least the intermediate phase of the response.</p>
General Public	<p>Members of the public are individuals who do not fit in the other three categories and are not considered part of the emergency response or clean-up operations. Members of the public outside of radiologically contaminated areas are likely to have different exposure pathways than those inside such areas, or those near the site of the explosion/release. Within this category, there are several important sub-groups that may require tailored risk assessments, such as people that are pregnant, children, people with disabilities, and people with certain pre-existing conditions. Responders should work with R-TWGs to identify relevant sub-groups and perform risk assessments based on the specifics of the incident.</p>

- 1244 ▪ **Conduct a dose assessment** for the various groups of people identified. These should be both
1245 retrospective and prospective, where appropriate, and be performed by skilled radiological
1246 personnel. Dose assessments combine the exposure pathways identified with the actual or
1247 estimated radiological conditions (source term) measured through monitoring and sampling and
1248 laboratory analyses described in Focus Area 1. Dose assessment is an ongoing, iterative
1249 process.²⁷
- 1250 ○ Prospective dose assessments will estimate the projected (future) exposure to
1251 emergency workers, remediation workers, essential employees, and members of the
1252 public.
- 1253 – Assessments for public exposure will inform comparison to PAGs in support of
1254 additional short and long-term evacuation, shelter-in-place, or relocation
1255 requirements.
- 1256 – Remediation workers should be assessed on an ongoing basis at appropriate
1257 intervals. Assessments for those working in contaminated areas should be
1258 reviewed by the lead jurisdiction’s R-TWG and/or the appropriate regulatory
1259 agency. These assessments should be outlined in relevant HASPs.
- 1260 ○ Retrospective dose assessment will estimate the exposure already incurred by
1261 workers (emergency, remediation, and essential) and the public. Retrospective dose
1262 assessment should:
- 1263 – Utilize the exposure information collected in Activity 2.2 to estimate exposures for
1264 emergency workers and members of the public located or operating within
1265 contaminated areas.
- 1266 – Rely on registration information for members of the public who are processed
1267 through community reception centers (CRCs) or other screening/
1268 decontamination locations/facilities, who are seen in a hospital or other
1269 healthcare setting as a direct result of the incident, shelters, or who were
1270 otherwise registered following exposure.
- 1271 – Include information on health effects experienced by any individuals who were
1272 potentially exposed to radiological material at or near the incident site. This
1273 information should include emergency workers as well as the public. Establish
1274 close coordination with medical facilities for monitoring and rapid reporting of any
1275 signs or symptoms of radiation exposure since this information will contribute to
1276 retrospective dosimetry and could provide important information during the early

²⁷ ICRP (2006) “The Optimisation of Radiological Protection: Broadening the Process. ICRP Publication 101.” Annals of the ICRP 36, no. 3 (2006): 65, 71–104. Available online at: <https://doi.org/10.1016/j.icrp.2006.09.007>.

1277 phases of an incident regarding radiological sources and the extent of the
1278 contamination.

- 1279 ■ **Incorporate technical guidance:** As an incident progresses, dose assessment will likely require
1280 the inclusion of subject matter expertise from both the private sector and state and federal
1281 partners, such as the DOE national laboratory network, the state radiation control programs, or
1282 contracted technical consultants. It is important to request and engage the assistance of
1283 specialized state and federal resources, such as the FRMAC, CDC Inorganic and Radiation
1284 Analytical Toxicology (IRAT) Branch, early in the incident response and recovery process to obtain
1285 outside assistance to support dose assessment processes.

1286  **Recommended Resources:**

- 1287 ■ *Field Guide for Health and Safety Officers: Radiological Incidents, Part 1 Operational*
1288 *Guidance and Part 2 Background Information.* (New York City Department of Health and
1289 Mental Hygiene, June 2014) <https://remm.hhs.gov/fieldguide.htm>
- 1290 ■ NCRP Report 161, *Management of Persons Contaminated with Radionuclides.* (2008)
- 1291 ■ 10 CFR 20 “[Standards for Protection Against Radiation](#)”
- 1292 ■ *Suggested Training and Experience Qualifications for Health and Safety Officers During a*
1293 *Radiological Incident* - PubMed (nih.gov) <https://pubmed.ncbi.nlm.nih.gov/31842135>

1294 **Activity 2.2: Implement an Exposure/Dose Record Process for Emergency**
1295 **Workers, Remediation Workers, and Essential Employees**

1296 **Exposure Information Collection Requirements:**

- 1297 ■ Identifying information: name, badge number, unit/team
- 1298 ■ Specific activity(ies) performed in a contaminated area and location
- 1299 ■ Start and end time of activity(ies) in a contaminated area
- 1300 ■ List of any PPE worn
- 1301 ■ Total dose recorded on responder instrumentation, if available
- 1302 ■ Instrumentation type and number, if available
- 1303 ■ Highest exposure rate recorded, if available
- 1304 ■ **Conduct initial data collection.** For emergency workers or other workers who are completing their
1305 duty in the affected area or otherwise demobilizing after the initial incident response, exposure
1306 information should be collected to the extent it is available. If no RHSO is available, other
1307 personnel may be assigned to oversee collection of exposure data on a contingency basis. The

1308 information gathered during this initial data collection effort will be required to perform the dose
1309 assessments described in Activity 2.1.

1310 ■ **Provide monitoring equipment.** Procure and deploy additional radiation dosimeters and/or
1311 personal detection equipment that can record total dose. This deployment should be done as
1312 soon as possible, especially after life-saving activities have concluded and sustained response
1313 activities are underway.

1314 ○ Every individual who enters the HZ or DRZ should be issued a personal dosimeter
1315 that can provide a dose reading in real-time. Ideally, personnel should also be
1316 provided a dosimeter or a personal radiation detector (PRD) that emits an audible
1317 alarm triggered by predetermined thresholds. In addition to tracking total received
1318 dose for potential health effects, these dosimeters also support a requirement to
1319 provide a legal (officially recorded) record of dose received by radiation workers.

1320 ○ In situations involving a shortage of PRDs, guidance from the National Council on
1321 Radiation Protection (NCRP) provides details on how to use limited PRD resources
1322 most effectively.^{28,29} Specifically, this guidance entails the use of group dosimetry
1323 (issuing a single dosimeter to a group of people who remain in proximity or work in
1324 the same area).

1325 ■ **Set operational goals for radiation exposure.**

1326 ○ Operational goals are aimed at preventing people from exceeding regulatory radiation
1327 dose limits, described in Table 9. Operational goals can be a combination of
1328 procedural (e.g., wearing dosimetry that is periodically checked) and administrative
1329 measures (e.g., assigning stay-times or dose limits).

1330 ○ Operational goals are based on two factors:

1331 – Exposure rate: The intensity of radiation an individual is exposed to expressed as
1332 the amount of ionizing radiation in the person’s vicinity per hour.

1333 – Total dose: The total amount of radiation absorbed (dose) for an individual over a
1334 given period of time (e.g., total radiation absorbed by the person in a year).

28 NCRP (2017) “Report 179: Guidance for Emergency Response Dosimetry.” Available online at:
<https://ncrponline.org/shop/reports/report-no-179-guidance-for-emergency-response-dosimetry-2017/>

29 NCRP. (2019) “Commentary 28, Implementation Guidance for Emergency Response Dosimetry.” Available online at:
<https://ncrponline.org/shop/commentaries/commentary-no-28-implementation-guidance-for-emergency-response-dosimetry/>

1335 Table 9: **Guidance on Dose Decision-Point Thresholds (Exposure rate in area (R/hr, Gy/hr))³⁰**

Guideline	Activity	Condition
> 10 mR/hr (0.1 mGy/hr)	Work in Hot Zone (HZ)	All personnel working in the HZ should have appropriate training and PPE (including radiation dosimeters) for all hazards they are expected to encounter.
> 10 R/hr (1 Gy/hr) ^{a, b}	Work in Dangerous Radiation Zone (DRZ) – lifesaving activities	Entry into the DRZ should only be made to conduct life-saving actions or attempting to prevent a catastrophic situation and with the informed consent of those making the entry.
Total dose to the worker (rem, Sv)		
5 rem (50 mSv) ^{a, c, d, e, f, h, i}	Annual occupational limit for radiation workers under routine circumstances	All reasonably achievable actions have been taken to minimize dose.
5-10 rem (50-100 mSv) ^{a, b, e, i}	Protecting critical infrastructure necessary for public welfare (e.g., a power plant)	Exceeding 5 rem (50 mSv) is unavoidable and appropriate actions have been taken to reduce dose. Monitoring is available to project or to measure the dose to individuals
10-25 rem (100-250 mSv) ^{a, b, e, h, i}	Lifesaving or protection of large populations	Exceeding 5 rem (50 mSv) is unavoidable and all appropriate actions have been taken to reduce dose. Monitoring is available to project or to measure dose.
25-50 rem (500 mSv) ^{a, b, e, h, i}	Lifesaving or protection of large populations	All conditions for exceeding a dose of 25 rem have been met and those making the entry are fully aware of the risks involved.

- 1336 **Perform ongoing data collection.** Establish a routine process for recording and tracking essential
 1337 information each time a person enters or exits a contaminated area or an area of elevated

³⁰ ^a Medical monitoring should be considered for potential doses in excess of 5 rem (50 mSv), ^b In the case of large-scale incidents (e.g., nuclear detonations), the Incident Commander should consider raising the dose guidelines to prevent large-scale loss of life and widespread destruction, ^c EPA Protection Action Guides (2017), ^d NCRP 1993, ^e ICRP 2005, ^f CRCPD 2006, ^g IAEA 2006, ^h DHS 2008, ⁱ NCRP 2010

1338 exposure rate. This process should be outlined in detail in the HASP, and all personnel working
1339 on site should be familiar with the purpose and importance of this data collection process.

1340 ○ Dose management for contractors conducting remediation work should be
1341 documented in a specific HASP or HASP supplement.

1342  Recommended Resources:

1343 ■ [NCRP Commentary Number 28](#) includes helpful ICS-oriented worksheets that can be
1344 integrated into response plans and protocols to facilitate this process.

1345 ■ National Council on Radiation Protection and Measurements. (NCRP) *Commentary 19, [Key](#)*
1346 *[Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism.](#)*
1347 (2005)

1348 ■ NCRP *Report 165, [Responding to a Radiological or Nuclear Terrorism Incident: A Guide for](#)*
1349 *[Decision Makers.](#)* (2010)

1350 **Activity 2.3: Determine Personal Protective Equipment Requirements for the**
1351 **Contaminated Area**

1352 ■ Identify PPE requirements for:

1353 ○ **Emergency Workers:** Emergency workers may require PPE if/when they enter
1354 contaminated areas to conduct emergency response work, such as providing
1355 emergency medical support, search and rescue, law enforcement activities,
1356 firefighting, and gross decontamination. Specific PPE requirements will depend on
1357 the type of hazards associated with a specific work activity as well as the radiological
1358 hazards posed by the incident. The RHSO should ensure that personnel entering
1359 contaminated areas are provided with PPE consistent with the hazards and exposure
1360 pathways identified in the contaminated area and the type of work being performed.
1361 Note that in some cases no special PPE may be required to perform work in
1362 contaminated areas; for example, some sources of penetrating ionizing radiation
1363 (such as gamma emitters) will pose a hazard regardless of PPE worn. In such
1364 scenarios, protection is ensured through dosimetry, exposure monitoring, and limiting
1365 time in the contaminated area rather than by relying on other types of PPE clothing or
1366 filtration systems.

1367 ○ **Essential Employees:** Workers who must enter the contaminated area to conduct
1368 non-radiological work will require PPE guidance specific to the hazards on the site
1369 and dosimetry. Depending on the exposure pathways identified, this protection could
1370 range from no additional PPE (level D) to PPE including respiratory protection if
1371 resuspension is a concern. This group will also require just-in-time radiation safety
1372 training.

- 1373 ○ **Remediation Workers:** Remediation workers will require PPE appropriate for their
1374 identified exposure pathways and type of work performed and dosimetry. Required
1375 PPE should be documented in the HASP, which should be reviewed by appropriate
1376 regulatory bodies (e.g., local and state health departments), safety officer, and/or R-
1377 TWG, as appropriate.
- 1378 ○ **General Public:** Members of the public are not expected to require PPE, since access
1379 to areas with harmful or potentially harmful levels of contamination should be
1380 controlled and limited to those people having a need to enter the area. Members of
1381 the public with a need to enter a contaminated area should be provided with
1382 dosimetry.
- 1383 – If resuspension is a concern, then particulate respiratory protection against dust
1384 inhalation may be necessary.
- 1385 – If removable (external) contamination is a concern, then either coveralls or a
1386 change of clothing may need to be provided at evacuation exit points.
- 1387 ■ Conduct just-in-time training on PPE utilization for anyone required to utilize it unless they have
1388 previous training that remains up to date.

1389 **Activity 2.4: Mitigate Spread of Contamination**

- 1390 ■ Implement engineering controls, administrative controls, and decontamination techniques to
1391 keep contamination as close to the initial source as possible, preventing further spread within
1392 and outside of the contaminated area boundary. There are three primary categories of control
1393 techniques:
- 1394 ○ To the extent feasible, retrieve and remove large sources of contamination.
- 1395 – This technique may be especially important if some or all the radioactive material
1396 is in discrete chunks or fragments.
- 1397 ○ Implement **engineering controls** to physically contain contamination in-place. These
1398 controls would include:
- 1399 – Encapsulating sources and contamination, ideally with dense or thick material
1400 (e.g., fixatives, lead bricks, concrete, and other dense barriers) that also provide
1401 shielding from gamma or beta radiation.
- 1402 – capturing run-off water to prevent transport of material through the environment.
1403 This technique may be especially applicable in scenarios in which a fire is
1404 involved or where sprinkler systems have been activated by an explosion, but
1405 only if berms and dykes can be deployed safely and effectively. Other
1406 considerations include limiting runoff from a standoff distance, such as by

1407 remotely damming stormwater drainage sewers for later pumping and removal of
1408 contaminated runoff.

1409 ○ Establish **administrative controls** to prevent access to areas with elevated exposure
1410 or significant contamination. This includes:

1411 – Providing just-in-time training to personnel who are working in or near the
1412 affected areas to limit any further spread of contamination.

1413 – Setting up physical boundaries (see Activity 1.5) to control access.

1414 – Conducting routine and job-specific radiological monitoring.

1415 – Posting signs that identify hazards (e.g., marking out an HZ boundary or hot spot).

1416 – Implementing mandatory screening and decontamination checkpoints at
1417 designated exits from contaminated areas.

1418 ○ Conduct expedient environmental **decontamination** intended to reduce exposure to
1419 personnel working in the area. These actions do not represent “long term” or “final”
1420 decontamination, but rather are intended to address the threat posed by radioactive
1421 material in a way that reduces the possible exposure for personnel working in the
1422 affected area. Examples include removal of large sources of contamination—such as
1423 chunks or fragments, if present—to reduce exposure to people traversing the area.
1424 Decontamination techniques supporting short-term mitigation will overlap to some
1425 degree with techniques used to complete full remediation (discussed in Focus Area 7
1426 and Annex B). However, these techniques may be appropriate over a shorter time
1427 frame and could potentially take advantage of resources that are immediately
1428 available.

1429  **Recommended Resources: Radiological Recovery Logistics Tool (RRLT)**

1430 The RRLT is a web-based tool currently in development to assist federal, state, local, tribal, and
1431 territorial organizations with identifying appropriate commercial and public works equipment to
1432 mitigate, remove, and contain radiological contamination following a large-scale release. It is
1433 particularly relevant for preparing early and intermediate-phase mitigation actions before the
1434 organized, contractor-conducted remediation operation has begun. The tool provides solutions
1435 for five support goals:

- 1436 ■ Mitigation of received dose to first responders
- 1437 ■ Containment of wastewater
- 1438 ■ Decontamination (gross and final)

- 1439 ▪ Solid waste management
- 1440 ▪ Survey and monitoring
- 1441 ▪ The RRLT can be accessed online at:
- 1442 https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=357559&Lab=CESER



Recommended Resources:

- 1444 ▪ Public Health England. *UK Recovery Handbooks Radiation Incidents 2015: Inhabited Areas Handbook*. Version 4.1. (June 2015.)
- 1445 [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachme](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/775712/inhabited_areas_handbook_2015.pdf)
- 1446 [nt_data/file/775712/inhabited_areas_handbook_2015.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/775712/inhabited_areas_handbook_2015.pdf).
- 1447
- 1448 ▪ Federal Emergency Management Agency. *Nuclear/Radiological Incident Annex to the*
- 1449 *Response and Federal Interagency Operational Plans*. (U.S. Department of Homeland
- 1450 Security, October 2016.) [https://www.fema.gov/sites/default/files/2020-](https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf)
- 1451 [07/fema_incident-annex_nuclear-radiological.pdf](https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf).

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Strategy 2: Communicate

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Focus Area 3: Public Communications

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***Guidance:** Provide timely emergency messaging in the early and intermediate phases of the incident focusing on protective actions. Identify, develop, and implement communication strategies for long-term concerns, including a focus on building literacy around radiological hazards, and setting expectations for a potentially extended recovery and reoccupation timeline. Utilize **trusted sources** and coordination mechanisms to ensure messaging is effective and the affected community's issues, concerns, and equities are being addressed appropriately. Include appropriate representation from the affected community in long-term communications strategy development and implementation.*

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Recommended Planning Partners:

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- Emergency management
- Public Information Officers (PIOs)
- Elected and appointed officials
- Public health departments and stakeholders
- Law enforcement officials
- Public/private partnerships
- Radiological subject matter experts
- Community based organizations/**trusted sources**

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Key Terminology: Trusted Sources

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Trusted Sources: Trusted sources are members of the community who can serve as nodes for dissemination of information to the public as well as a feedback mechanism to facilitate bidirectional communication. A trusted source will know the history and context of their specific community and how that community likes to receive information both in style/wording and in method of dissemination (e.g., media, social media, printed materials, webinars, townhalls, etc.). Trusted sources may include religious leaders, community organizers, charity organizations, union leadership, etc.

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Inclusion of trusted sources will help ensure that credible information reaches and is more likely to be accepted by people and communities that may otherwise have limited access to such information or be untrusting of the official spokesperson(s).

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Key Terminology: Misinformation, Disinformation, and Malinformation³¹

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Misinformation: False information that was not created or shared with the intention of causing harm.

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Disinformation: Deliberately created false information with the intention of misleading, harming, or manipulating a person, social group, organization, or country.

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Malinformation: Information based in fact but used out of context to mislead, harm, or manipulate. An example of malinformation is editing a video to remove important context to harm or mislead.

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Introduction

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Timely, authoritative, and easy-to-understand communication, including for individuals with limited English proficiency and individuals with disabilities, is a key factor underpinning response and recovery actions across all protective action phases. Radiological hazards tend to be unfamiliar, invisible in their manifestation, and potentially frightening to members of the public. Public risk perception may either be overly heightened, with excessive fear regarding any presence or detectable level of radioactivity regardless of the actual radiation hazard, or overly dismissive of a seemingly imperceptible threat. Considering such concerns, messaging will need to explain what happened, as well as radiation risk and protective actions in a simple and easy-to-understand way and include reasoning for why the public is being asked to take a particular action. Such messaging should be conducted in partnership with **trusted sources** within the affected community(ies) to maximize the number of people who follow authoritative protective action guidance. Additionally, as the impacts from a radiological incident are likely to extend well into the late phase, messaging also will need to help set the expectation of a long road to recovery. The public should be made aware that as the situation develops, and more information becomes available, protective actions, cleanup plans, and recovery schedules are likely to change.

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The *First 100 Minutes Guidance* describes the immediate public alerts and warnings and messaging that must be disseminated after an RDD detonation. These include an initial announcement of the incident, shelter-in-place and evacuation recommendations/instructions, self-decontamination instructions, and a press release/conference. As the extent of contamination and its impacts are further characterized in the hours and days that follow, PIOs will need to update and expand upon their emergency public safety messaging, while simultaneously combatting misinformation, malinformation, and disinformation, and begin to identify intermediate and late-phase communication priorities and potential community engagement strategies. Due to the importance of timely and accurate messaging that is actionable and linguistically appropriate for all populations, early phase messaging should employ pre-scripted or pre-approved language to the greatest extent

³¹ Cybersecurity & Infrastructure Security Agency (CISA). *Foreign Influence Operations and Disinformation*. Available online at: <https://www.cisa.gov/topics/election-security/foreign-influence-operations-and-disinformation>

1516 possible. There are numerous pre-existing communication guides specific to radiological incidents
 1517 that include templates for creating messaging materials, Frequently Asked Questions (FAQ)
 1518 documents, instructional videos and more. Training specific to communicating radiation risks in the
 1519 aftermath of a radiological or nuclear disaster is also available. A selection of communication
 1520 resources is provided in Annex C of this guidance.



Coordination Opportunity: Sharing in a JIC

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1522 Information sharing between FSLTT agencies and the public in the context of an RDD incident
 1523 should be consolidated within a Joint Information Center (JIC). A JIC is where PIOs from all
 1524 relevant agencies can discuss and coordinate public messaging and leverage shared
 1525 resources, such as GIS specialists producing maps that help provide a visual characterization
 1526 of an incident. The National Incident Management System (NIMS) describes JIC roles and
 1527 responsibilities. Coordinated and consistent messaging is particularly important for RDD
 1528 incidents where there is likely to be a lot of fear among the public and the consequences of
 1529 misinformation could be severe.

1530 **Table 10: Summary of Focus Area 3 Activities**

	Activity	Phase
3.1	Provide New and Updated Early Phase Emergency Messaging	Early (Hours)
3.2	Identify and Develop Intermediate and Late-Phase Communication Strategies	Intermediate to Late (Days to Weeks)
3.3	Assess and Improve Communications Efforts	Late (Weeks to Months)

1531 **Activity 3.1: Provide New and Updated Early Phase Emergency Messaging**

- 1532 ▪ Release early phase emergency messages to the public. These messages should employ pre-
 1533 scribed or pre-approved language to facilitate the timely dissemination of critical information
 1534 and life safety guidance.

- 1535 ▪ Incorporate radiation experts into the message development and review process in the context of
 1536 both pre-incident planning and actual incident response and recovery activities. Experts may
 1537 include SMEs from state radiation protection programs, state and local health departments, or a
 1538 Radiological Operations Support Specialist (ROSS).

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High-Priority Topics for Early-Phase Messaging

- What happened? Include maps of the impacted areas, information on the type of impacts (e.g., infrastructure, services, agricultural embargoes) and areas with access restrictions or relocation needs.
 - What actions need to be taken by members of the public? Include information about PPE use, shelter-in-place instructions, relocation information, where to seek contamination screening and medical care, and how to self-decontaminate people, pets, and personal items.
 - Guidance on whether food, water, and air are contaminated and how to safely consume food and water.
 - Who is leading the response? Identify the lead agency or agencies and provide instructions regarding where people can go for information or to ask questions.
 - When the next update will be provided.
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- Build basic scientific literacy by using easy-to-understand language. The public likely has limited knowledge of radiation-related concepts. Use easy to understand visuals such as infographics. Provide basic background information and simplify complex technical information to enhance understanding of the situation and related protective action guidance.
 - Manage expectations. As the situation develops, and more information becomes available, protective action recommendations for the public may change. It is important to emphasize that change is expected given the special dynamics of an RDD incident. The public should also be prepared for the likelihood that the timeline of response and recovery for an RDD incident will be significantly longer compared to other types of disasters.
 - Pre-identify the best outlets and platforms to facilitate information sharing for both immediate, high-urgency messages (such as evacuation or relocation instructions or PPE use) and lower-urgency messages (such as updates to expected response and recovery timelines). Systems such as FEMA’s Integrated Public Alert and Warning System (IPAWS) and Wireless Emergency Alert (WEA) System often have strict character and format limitations, so pre-scripting is especially important. Templated messages should be translated into all languages commonly used in the area and be made accessible to people with access or functional needs.
 - Identify or establish liaisons between radiation safety technical working groups and the communications structures supporting incident response and recovery, including the JIC once activated.
 - Ensure available means of communications are sufficient to reach community members affected by the RDD incident. Since RDDs do not generate an electromagnetic pulse (EMP), communication infrastructure is unlikely to be affected during an RDD event beyond any physical infrastructure that may be damaged by the blast in the immediate area or saturation of a system

1575 based on a user spike created by the incident. However, jurisdictional communication plans that
1576 rely on in-person communication to reach certain populations, particularly those with access or
1577 functional needs, may need to be altered for those in and around a contaminated area.

- 1578 ■ Develop a communications strategy for first responders, remediation workers, and essential
1579 employees as defined and discussed in Focus Area 2. Such individuals may not have hazardous
1580 materials training or even a basic knowledge of radiological concepts. However, they may be
1581 expected to work in or adjacent to contaminated areas. First responders, remediation workers,
1582 and essential employees will need to be reassured and affirmed of their safety, provided the
1583 appropriate resources to address their mental health and physical well-being, and be reminded
1584 of their critical role in mitigating impacts to the community that they serve.



1585 Coordination Opportunity: Radiological Operations Support Specialist (ROSS)

1586 A ROSS is an individual with radiological expertise and an understanding of the Incident
1587 Command System (ICS) available to state, local, tribal, and territorial emergency managers,
1588 responders, and decision-makers. ROSS are FEMA-typed and can be requested through
1589 mechanisms such as the Emergency Management Assistance Compact (EMAC). For more
1590 information, visit: https://www.fema.gov/sites/default/files/2020-07/fema_cbrn-ross.pdf

1591 Activity 3.2: Identify and Develop Intermediate and Late-Phase 1592 Communication Strategies

- 1593 ■ Intermediate and late phase messaging can be more difficult to pre-script than early-phase
1594 messaging, since it will be harder to predict the specific needs and concerns of an impacted
1595 population days, weeks, months, and years into a recovery effort. However, existing
1596 communications resources (listed in Appendix C) can be used to help address many of the
1597 questions that are likely to arise during the later phases of an incident.
- 1598 ■ Invite community leaders and trusted sources to participate in the development of messages
1599 and message deployment strategies. The community should be (and ultimately will be) involved
1600 in decision-making, so it is important to craft messages that will be received, understood, and
1601 accepted by the impacted public, including those who may not be easily reachable by traditional
1602 communication routes or those who may distrust official messaging channels.



1603 Recommended Resources: Medical and Radiation Risk Messaging Resources

1604 Communicating health-related radiation risks is necessary for the public to understand
1605 that their actions can protect them from short- and long-term health effects.

1606 Communications should include descriptions of symptoms of radiation injury, what to do and
1607 not to do, expected timeframes during which symptoms may appear, and when and where to

1608 seek medical care. PIOs can leverage existing resources and messages, such as CDC’s public-
1609 facing webpages and medical resources.

1610 ▪ FAQ for radiation emergencies:
1611 <https://www.cdc.gov/nceh/radiation/emergencies/emergencyfaq.htm>

1612 ▪ Acute Radiation Syndrome (ARS): A Fact Sheet for the Public:
1613 <https://www.cdc.gov/nceh/radiation/emergencies/ars.htm>

1614 ▪ Preventing and Treating Radiation Injuries and Illness:
1615 <https://www.cdc.gov/nceh/radiation/emergencies/symptoms.htm>

1616 ▪ EPA Communication Resources: <https://www.epa.gov/radiation/pag-public-communication-resources>
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1618 **High-Priority Topics for Intermediate and Late-Phase Messaging**

1619 ▪ What is happening now? Include updated maps, more details about the incident (as they
1620 become available for public dissemination) and key response and recovery activities and
1621 timelines, and who is actively responding to/managing the incident. Include maps of areas
1622 that are contaminated, under protective action recommendations, or subject safety guidance
1623 such as a “Do Not Drink” order, an agricultural embargo, or other lesser restrictions.

1624 ▪ What’s happening next? Include what the incident management priorities are for the
1625 foreseeable future and provide a timeline (if available) for recovery efforts.

1626 ▪ How to mitigate exposure and personal risk. Include information on decontamination (for
1627 people, animals, and property), safety instructions for personal property recovery/retrieval,
1628 PPE use, and food/water safety.

1629 ▪ How to recover personal property (including pets, medicines, personal belongings, etc.) or
1630 make claims for irretrievable personal effects.

1631 ▪ Include instructions for receiving housing, food, healthcare, and economic assistance. During
1632 the recovery phase, include contact information, eligibility requirements, and instructions for
1633 accessing available financial aid, including governmental assistance, and/or insurance
1634 reimbursement, if applicable.

1635 ▪ How to engage with response and recovery officials. Include information about meetings,
1636 hotlines, and other ways that the public can ask questions and/or offer feedback on the
1637 recovery process.

1638 ▪ Cleanup and reoccupation decision-making and progress. Share what will and will not be
1639 cleaned up, to what levels places will be cleaned up, who makes cleanup decisions, cleanup
1640 methods, cleanup timelines, and associated information sharing needs for regular updates
1641 and unexpected incidents during cleanup. Explain any continued precautions, estimated
1642 reoccupation timeline, and any ongoing land-use restrictions. Describe how the environment

1643 will be monitored and what long-term impacts are expected on water supply, wildlife, and
 1644 agriculture.

1645 **Activity 3.3: Assess and Improve Communications**

- 1646 • Assess the impacts and effects of messaging during RDD incident response and recovery. An
 1647 RDD incident likely will generate a great deal of fear and uncertainty in the community, and it
 1648 is also a topic that the public is typically not very knowledgeable about. Additionally,
 1649 background radiation can be present in the environment at levels that are very low and
 1650 below all thresholds of concern, and for reasons unrelated to the RDD detonation. These
 1651 factors make communication during and following an RDD incident more challenging and
 1652 may lead to misunderstanding of important messages and the spread of misinformation,
 1653 malinformation, and disinformation.

- 1654 ▪ Involve trusted sources in communications efforts throughout the pre-planning, response,
 1655 and recovery phases of an incident. Trusted sources (included in Table 11 below) may be
 1656 able to provide valuable feedback about how messaging is received by certain demographic
 1657 groups, whether messaging is reaching the targeted audience, and how communications can
 1658 be improved. Trusted sources can also be powerful allies in combatting misinformation,
 1659 particularly among groups that are distrustful of official sources.

1660 **Table 11: Examples of Trusted Sources**

Organization Type	Trusted Source Examples
Healthcare sector	Doctors in private practice, veterinarians, dentists, hospital spokespersons, public health officials
Local businesses	Convenience stores and bodegas, restaurants, pharmacies, retailers
Local media	Local journalists, news platforms
Education institutions	Teachers and professors, school nurses, athletic coaches
Faith-based organizations	Houses of worship, charity organizations
Real-estate sector	Co-op boards, real estate agents, property managers
Academic organizations	Verified experts in radiation, health physics, or public health fields, science communication experts, academic associations
Union/Trade associations	Public and private-sector union leadership
Canvassing organizations	“Get-out-the-Vote” and Census canvassers
Local government	Individual, public-facing employees such as transit workers, homeless outreach, and sanitation staff

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- Periodically reassess the reach that partnered organizations, **trusted sources**, and official communication channels have within the community as the incident progresses. Certain groups, such as essential workers, may require more intensive outreach, the engagement of specific **trusted sources** (e.g., union organizers, social workers, healthcare providers, etc.), and additional focused messaging.
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- Frequently survey for outdated information, misinformation, malinformation, and disinformation, and swiftly address or correct any inaccuracies. As time passes or incident conditions/objectives change, new information vacuums and channels of misinformation, malinformation, and disinformation are likely to develop. Addressing outdated information and misinformation will be especially important as updates become less frequent or less specific during the intermediate and late phases of recovery.



Recommended Resources: Annex C

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See Annex C: Radiological Communications Tools.

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Strategy 3: Monitor and Assist

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Focus Area 4: Conduct Phased Evacuation

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Guidance: Plan for and execute a phased evacuation using geographically defined Evacuation Zones to assist with the prioritization of resources. Implement search and rescue, including canvassing operations to confirm evacuation compliance and assist populations with access and functional needs.

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Recommended Planning Partners:

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- Environmental protection

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- Emergency management

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- Fire/police/EMS

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- Public health

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- Remediation contractors

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- Transportation

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Introduction

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The activities described in this focus area outline the major steps necessary to plan for and execute an evacuation to safely move people who are sheltering in place out of the contaminated area in a timely fashion and in accordance with government-provided guidance. Unlike traditional evacuation planning for events where there are hours or days of advance notice (e.g., special events, coastal storms, and sometimes even nuclear power plant emergencies), an evacuation based upon an RDD incident will occur in an environment where resources have not been pre-staged and the public likely is unaware aware of any designated evacuation zone or evacuation protocols in advance. Such a scenario requires flexible planning and careful prioritization of resources while balancing the risks of evacuation and potential exposure to radiation hazards versus the risks of prolonged sheltering in place.

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Lessons Learned from Fukushima

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Fukushima demonstrated that the “assessment of the tradeoff benefits between sheltering and evacuation needs re-emphasis. Evacuation strategies should be based on minimizing risk to the public from all causes.” Planners should consult [NUREG/CR-7285, “Nonradiological Health Consequences from Evacuation and Relocation”](#) for additional lessons learned about this topic.

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https://web.mit.edu/nse/pdf/news/2011/Fukushima_Lessons_Learned_MIT-NSP-025.pdf

1704 <https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7285/index.html>

1705 The first priority for evacuation following an RDD detonation is to remove people out of situations
1706 that are immediately dangerous to their life, such as building fires, unstable structures, and very high
1707 radiation exposure rates where sheltering is not feasible.

1708 The *First 100 Minutes Guidance* largely addresses this priority. Evacuation of people in these
1709 situations should be underway or completed as the strategies and focus areas in this *RDD Recovery*
1710 *Guidance* are initiated. Due to risks associated with evacuation itself, the Fukushima experience
1711 taught that it may be advisable to leave people sheltering in place longer until a safe evacuation can
1712 take place. All risks, including long-term health risks, should be considered when developing the
1713 evacuation plan. In general, conducting a phased evacuation does not mean stopping or delaying
1714 necessary medical evacuations out of the area (such as by EMS transport) for any life-threatening
1715 conditions or medical emergencies that may emerge.

1716  **Recommended Resources: Consequences from Evacuation and Relocation**

1717 Evacuation and relocation have inherent risks, ranging from increased risks of anxiety and
1718 PTSD to increased rates of diabetes or cardiovascular disease. For more information, see the
1719 Nuclear Regulatory Commission's (NRC's) 2021 report on the Nonradiological Health
1720 Consequences from Evacuation and Relocation (NUREG/CR-7285), available online at:
1721 <https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7285/index.html>

1722 The *First 100 Minutes Guidance* also describes initial shelter-in-place priorities, such as prompt
1723 notification to the public to shelter in place in areas that are 500 meters extending in all directions
1724 from the detonation point and 2000 meters in the direction of the contamination plume. Although
1725 this area represents a relatively small area compared to other types of major evacuation operations,
1726 the possibility exists that the additional characterization conducted as part of the 10 Point
1727 Monitoring Survey and Tactics 1, 2, and 8 in the *First 100 Minutes Guidance* will entail a significant
1728 expansion of the recommended shelter areas. For a very large radiological release, this expansion
1729 could result in multiple neighborhoods – potentially tens of thousands of people in a densely
1730 populated area – being advised to remain indoors while responders continue to gather information
1731 and plan for a safe evacuation process. It also will be important to communicate the shelter-in-place
1732 timeline and expectations to the public (see Focus Area 3).

1733 An RDD-based evacuation operation requires planning and execution tailored to the particular areas
1734 affected and the resources available to conduct the evacuation. Communities should plan for and
1735 implement phased evacuation with consideration given to the population numbers and density of the
1736 area to be evacuated, types of buildings in which people are located (e.g., high-rise condos,
1737 apartments, homes), availability of privately owned vehicles (POVs) and public modes of
1738 transportation, and time available for evacuation operations to be completed.

1739 A phased evacuation will maximize the safety of the impacted population by prioritizing evacuation of
 1740 those in the areas of highest radioactivity exposure and those with urgent medical conditions, while
 1741 controlling the flow of evacuees. This ensures available resources, such as personnel to operate
 1742 screening and decontamination stations or checkpoints for those exiting the contaminated area, are
 1743 not overwhelmed.

1744 Focus Area 4 guides planners through the main concepts associated with evacuation planning and
 1745 implementation, beginning with the designation of evacuation zones based on data collected
 1746 through activities described in Focus Areas 1 and 2. These are largely determined by the hot zone
 1747 boundaries and areas where safety guidelines provided in Protective Action Guides (PAGs) are
 1748 exceeded. From there, planners and responders should match evacuation resources and methods
 1749 (e.g., vehicle-assisted vs directed self-evacuation) to each zone and determine the order in which
 1750 evacuation will commence.

1751 Finally, this focus area provides guidance for conducting search and rescue, including canvassing
 1752 operations to determine the success of evacuation and identify people remaining in the area who
 1753 may require additional assistance to evacuate safely. While area canvassing is a common follow-up
 1754 to any mass evacuation operation, performing such operations in the contaminated area will pose
 1755 challenges, including ensuring the protection of the health and safety of canvassers. Focus Area 4
 1756 activities are informed by specific data requirements (e.g., population density of contaminated area
 1757 and type of activity in the contaminated area such as office, manufacturing, etc.) further discussed in
 1758 Annex B.

1759 **Table 12: Summary of Focus Area 4 Activities**

	Activity	Phase
4.1	Identify Areas Where People Will Require Evacuation, Release from Shelter-in-Place (SIP) or an Extended Period of SIP	Early to Intermediate (Hours to Days)
4.2	Mobilize and Execute a Phased Evacuation Over the Next Few Days	Early to Intermediate (Hours to Days)
4.3	Conduct Search, Rescue, and Canvassing Operations	Early to Intermediate (Hours to Days)

1760 **Activity 4.1: Identify Areas Where People Will Require Evacuation, Release**
 1761 **from SIP, or an Extended Period of SIP**

- 1762 ▪ **Gather information:** Gather and analyze critical incident information acquired through Strategy 1
 1763 activities, including:
 - 1764 ○ Radiological monitoring and sampling data/analysis, as described in Focus Area 1
 1765 (e.g., maps, aerial and vehicular monitoring data, and responder on-foot monitoring,
 1766 as well as laboratory analysis of samples, when available).

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- Exposure pathway analysis and dose projections for people in areas with significant contamination, as described in Focus Area 2.
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- State and local public health departments should leverage the IMAAC, FRMAC, and A-Team, and other specialized federal assets, as available to conduct this assessment.³²
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- State and local officials should be prepared to provide updated GIS data to assisting federal agencies, such as 9-1-1 street maps and address point locations. Additionally, FEMA may be able to coordinate with other federal partners to obtain anonymized information from wireless service providers indicating the population concentration within affected areas who have working cellular devices.



1778 Planning Tip: Verify Legal Authority for Mandatory Evacuation and SIP

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Statutory authority to compel evacuations and/or restrict movement (such as in an enforced shelter-in-place scenario) varies with state, tribal, and territorial law.

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- In some states, only the governor may require evacuation.

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- Some evacuation authorities are limited to specific hazard scenarios spelled out in law.

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- Local law enforcement and fire departments may also exercise police powers to limit access and/or compel evacuation in some situations.

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Check with emergency management officials and legal counsel to determine which authorities govern mandatory evacuation of any designated evacuation and/or relocation zones.

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- **Establish zones:** Identify the following three types of areas to inform early and intermediate phase evacuation and SIP decision-making:
 - **HZ and DRZ, where radiological exposures are >10 mR/hr and >10 R/hr, respectively.** These areas may be a priority for timely assisted evacuation during the immediate response; however, rushed evacuations can pose safety and health-risks that exceed those from radiation exposure. Even for areas within the HZ, planners must analyze the risks of conducting an evacuation balanced with the risks of extended temporary shelter-in-place.
 - **Areas with other physical hazards and individuals with access and functional needs.** Other life-safety hazards might prompt the need for evacuation, such as areas
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³² IMAAC support can be requested directly at IMAAC@fema.dhs.gov or 703-767-2003. For general inquiries or more information email IMAAC at IMAACinquiries@fema.dhs.gov. Support from the FRMAC and A-Team can be requested through the DOE (1-202-586-8100) and FDA (1-866-300-4374) emergency operation centers, respectively.

1797 containing non-radiological hazards that may worsen as sheltering time lengthens.
1798 Typically, this would be due to a loss of a critical utility (e.g., HVAC on a hot/cold day,
1799 clean drinking water, sanitation services, as well as at-home health care services
1800 such as those with medical equipment requiring electricity, oxygen, etc.).
1801 Consideration should also include evacuation requirements for access and functional
1802 needs or special medical needs populations. Assessment of congregate care facilities
1803 and medical facilities requiring extensive evacuation support would fall into this
1804 category. Depending on the circumstances, non-radiological hazards may be the
1805 most important factor that determines high-priority evacuations.

1806 ○ **Relocation areas:** Areas where long-term clean-up may be needed, such as those that
1807 exceed the relocation criteria defined in EPA PAGs. Identification of relocation areas
1808 during the early phase should also balance radiological hazards with evacuation or
1809 relocation-associated hazards. Furthermore, not all areas identified as potential
1810 relocation areas will need to be evacuated over the first few days beyond the initial
1811 response if continued shelter-in-place is feasible.

1812 – For the radiological hazard, the EPA PAG recommends 2 rem/yr annual projected
1813 dose in the first year, and 0.5 rem in the second and subsequent years, as a
1814 threshold for a relocation area. For RDD incidents involving isotopes with
1815 relatively long half-lives, it may be necessary to base relocation decisions on the
1816 second and subsequent year dose projections. In these cases, evacuation may
1817 be a low priority, as the hazard likely will not exceed PAGs for some time. In these
1818 scenarios, decisions on relocation may need to be informed by detailed multi-
1819 year dose assessment and modeling projections. Additional precautions may also
1820 be necessary if the material distributed emits alpha radiation.

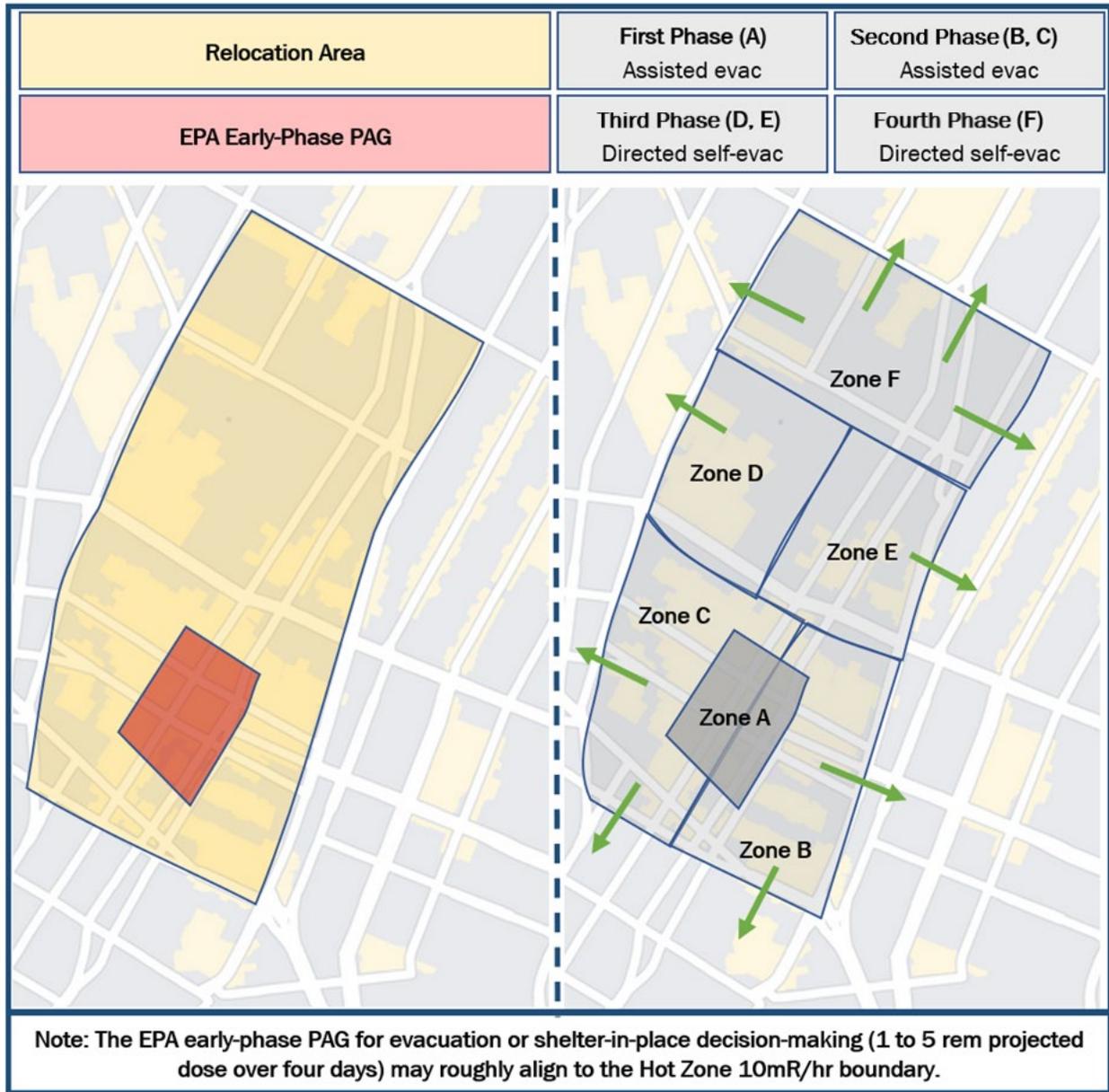
1821 – Demographic-specific dose thresholds for populations especially vulnerable to
1822 radiation exposure and non-radiation hazards (such as pregnant people and
1823 children) may justify prioritizing assisted-evacuation or an earlier self-evacuation.

1824 – Unnecessary or rushed evacuations can pose safety and health risks that exceed
1825 those associated with radiation exposure. These added risks include separation
1826 of vulnerable individuals from their home-area support systems/network of family
1827 and acquaintances, traffic hazards, and other stressors associated with
1828 evacuation and relocation. Since rushed or unnecessary evacuations can pose
1829 safety and health risks, it may be sensible to delay evacuation in some areas of
1830 the designated relocation zones to a later time. However, regarding those areas
1831 where evacuation is delayed, resources should be rapidly mobilized to support
1832 community needs associated with a prolonged shelter-in-place, if the resources
1833 exist to do so. If evacuation is necessary, it is unlikely that responders will be
1834 operating in the area for a long enough period to provide essential commodities,
1835 medicines, and services, in addition to providing food or addressing other needs
1836 of sheltered populations.

- 1837 ▪ **Determine timeline:** As soon as possible, identify which areas in the above categories will require
1838 evacuation over the next few days following the initial response, and then execute SIP and the
1839 phased evacuation processes described in Activity 4.2.
- 1840 ○ Planners should be aware that state and local authorities that deal with mandatory
1841 evacuation vary greatly from one jurisdiction to the next. Planners should identify all
1842 and understand all potential legal authorities available in a given context when
1843 planning and prior to conducting an evacuation.
- 1844 ○ Depending on the area requiring evacuation, it is possible that an RDD could result in
1845 a considerable and urgent need for mass care services, to include emergency shelter
1846 and housing. The decision-making process for timing phased evacuations should
1847 take into account the availability of mass care resources for people who do not have
1848 a primary or alternative housing option available to them.
- 1849 ▪ **Engage subject matter expert support:** To the extent practical, engage professionals and subject
1850 matter experts to support evacuation planning and decision-making. Resources to consider
1851 include mental health professionals, public health, the REAC/TS support network, radiation
1852 health professionals, and communications professionals.
- 1853 ▪ **Revise evacuation zone boundaries:** As additional characterization activities progress and
1854 greater technical knowledge about the event becomes available, be prepared to revise the
1855 relocation PAG boundaries and their associated evacuation zones. This revision may result in:
- 1856 ○ Some people who were evacuated being able to return to areas that were previously
1857 evacuated;
- 1858 ○ Evacuation of new or additional areas based on updated public health assessments;
1859 and/or
- 1860 ○ Implementation of short-term mitigation techniques (e.g., engineering,
1861 administrative, and environmental decontamination discussed in Focus Area 2) to
1862 reduce exposures to people evacuating, and/or people under prolonged shelter-in-
1863 place orders.

1864 **Activity 4.2: Mobilize and Execute a Phased Evacuation Over the Next Few**
1865 **Days**

- 1866 ▪ **Establish evacuation zones:** Divide areas requiring evacuation into **evacuation zones**, as
1867 necessary and as appropriate for the jurisdiction, to enable a managed, time-phased, and
1868 prioritized evacuation. Figure 6 provides a simplified example of this process.



1869

1870

Figure 6: Example of Time-Phased Evacuations.

1871

- **Prioritize areas of greatest exposure:** When dividing and prioritizing evacuation zones, consider the following factors:

1872

1873

- Areas with higher exposure rates or greater non-radiological hazards should be prioritized for evacuation over other areas. Consider grouping areas with similar characteristics, such as where similar types of hazards are identified (e.g., same PAG values exceeded, and similar area category as described in Activity 4.1).

1874

1875

1876

1877

- Recognizable geography and landmarks that facilitate responder and public identification of zones and movement through them. For example, this consideration

1878

- 1879 may mean identifying zones by zip code, voting precinct, fire service area, or
1880 locations of major roadways and public transportation.
- 1881 ○ Demographic and environmental characteristics that could impact feasibility of
1882 mobilization, the amount of assisted evacuation required, or lengthen or shorten the
1883 time required to complete evacuation. For example, areas with:
- 1884 – Populations with disabilities and other medical, access, and functional needs
- 1885 – Populations without vehicles
- 1886 – High population density
- 1887 ■ **Identify safest exit routes:** Send a survey team to conduct radiological monitoring and/or
1888 leverage existing survey data from Focus Area 1 to identify the safest routes out of each
1889 evacuation zone.
- 1890 ○ Establish evacuation corridors that are perpendicular to the plume centerline,
1891 identified through monitoring activities as described in Focus Area 1. This alignment
1892 will minimize potential exposure to radioactive contamination during the actual
1893 evacuation by reducing time spent in the contaminated area.
- 1894 ○ Radiation monitoring teams and all-hazard survey teams should identify
1895 contamination and other hazards that might need to be mitigated or removed, such
1896 as debris or disabled vehicles.
- 1897 ○ Radiation safety professionals should conduct an exposure/dose assessment for
1898 evacuees traversing the identified route and suggest adjustments, as needed. The
1899 FRMAC and the A-Team can assist with these assessments.^{33,34}
- 1900 ■ **Provide transportation assistance:** Identify and mobilize means for assisting evacuees with
1901 transportation. A combination of means will likely be necessary and should take into
1902 consideration any potential radiological (or other) hazards, including:
- 1903 ○ **On-foot:** For smaller-scale releases where pathway assessments have identified re-
1904 suspension to be a minor concern, or for circumstances where roadways are blocked
1905 by disabled/abandoned vehicles, emergency responder-directed on-foot evacuation
1906 may be feasible. Radiation health and safety experts should conduct exposure/dose
1907 assessments of the chosen routes out of the contaminated area. PPE may need to be

³³ More information about the FRMAC, can be found on the DOE Nevada National Security Site (NNSS) webpage on FRMAC: <https://www.nnss.gov/pages/programs/frmac/FRMAC.html>

³⁴ For more information about the A-Team, see the A-Team's website: <https://cdn.ymaws.com/www.crcpd.org/resource/resmgr/ATeam/Ateam1.htm>

- 1908 provided to people traversing on foot. Responders should direct evacuees through
 1909 identified evacuation paths.
- 1910 ○ **Common-carrier/mass transit:** Common-carrier and use of mass transit resources
 1911 can move a considerable number of people in a small amount of time and have the
 1912 added benefit of minimizing roadway bottlenecks. An exposure pathway assessment
 1913 for risk of resuspension should be conducted by radiation health and safety experts.
 1914 PPE may need to be provided to evacuees and/or operators of the vehicle. This
 1915 method is the most resource-intensive for response organizations. Additionally, if
 1916 mass transit vehicles are re-used for multiple trips, end-of-route screening and gross
 1917 decontamination may be necessary.
- 1918 ○ **Personally owned vehicle (POV):** In most locations, POV transportation will be the first
 1919 choice for any evacuation. However, POV transportation may not be available to
 1920 everyone in the zone to be evacuated. In addition, use of POVs may result in further
 1921 spread of radioactive contamination by re-suspension and physical transport on POV
 1922 surfaces. Regardless of instructions provided, some people will use POVs to evacuate
 1923 themselves from a contaminated area. Communities should plan for use of POVs,
 1924 with or without authorization, for evacuation and plan their resources accordingly.

1925



Key Terminology: Community Reception Center (CRC)

1926 The Community Reception Center (CRC) concept was created by the CDC to provide public
 1927 health officials with guidance for managing screening and decontamination of evacuees. More
 1928 information on planning for CRC operations is included in Focus Area 5. The CRC:

- 1929 ▪ Handles initial, radiation contamination screening, decontamination, registration, and
 1930 information.
- 1931 ▪ Collects information needed to track individuals for public health follow-up.

1932



Recommended Resources: CRC Toolkit

1933 The CDC's **CRC Toolkit** includes staffing requirements, necessary equipment lists, forms, drills
 1934 and exercise toolkits, and electronic applications for use in CRC operations:

1935 <https://www.cdc.gov/nceh/radiation/emergencies/populationmonitoring.htm>

- 1936 ▪ CDC also offers a guide to repurpose existing Point of Distribution (POD) plans for CRC
 1937 purposes.

1938 https://www.cdc.gov/nceh/radiation/emergencies/pdf/pod_to_crc_planning_tool-508.pdf

- 1939 ▪ **Screen evacuees:** If CRCs have been opened (See Focus Area 5), direct and/or transport
 1940 evacuees to these locations for radioactive contamination screening. If CRCs are not available

- 1941 and resources permit, establish ad-hoc screening and decontamination stations or checkpoints
1942 outside of the contaminated area and along the evacuation routes where evacuees can be
1943 rapidly screened, decontaminated (if necessary), and transported for medical treatment (if
1944 needed). These stations or checkpoints should:
- 1945 ○ Expeditiously check for gross external radioactive contamination of evacuees and
1946 provide any necessary emergency medical attention for physical injuries or other
1947 medical conditions in addition to gross decontamination (where appropriate). (See
1948 Focus Area 5 for more information)
 - 1949 ○ Be staffed with security and basic first aid providers, when available
 - 1950 ○ Provide basic provisions for evacuees traveling with pets (water and kennels, if
1951 available)
 - 1952 ○ Be operational in all weather conditions
 - 1953 ○ If POVs are used, checkpoints should provide space for screening and/or isolating
1954 vehicles that may be contaminated
 - 1955 ○ Review and record dosimetry of drivers who are transporting evacuees
 - 1956 ■ **Provide public messaging:** Notify the public of the phased evacuation process.
 - 1957 ○ Use targeted-messaging technologies and social media to communicate evacuation
1958 priorities to specific buildings and neighborhoods:
 - 1959 – Wireless emergency alerts (WEAs) distributed using FEMA’s Integrated Public
1960 Alert and Warning System (IPAWS) can be used to send geo-targeted instructions
1961 to people with cellular phones in most cases. Sending these alerts may also
1962 entail activation of the Emergency Alert System (EAS).
 - 1963 – Consider utilizing internet streaming and low-power FM transmitter stations for
1964 individuals to receive continuously broadcasting information about the
1965 evacuation.
 - 1966 – Some jurisdiction-specific emergency notification systems may also allow for
1967 targeted alerts based on address or other registration information. Many of these
1968 systems are subscriber-based and may be able to reach deaf and blind residents.
 - 1969 – Outdoor public address systems and route alerting by public safety agencies may
1970 also be of use; however, consider the placement of these systems (distance and
1971 separation of devices) and whether they will provide sufficient targeted
1972 information for individuals in the affected areas.

- 1973 – Messages should include multiple languages appropriate for the targeted areas
1974 and be sent through multiple modalities to ensure they are understandable by
1975 people with low English proficiency or disabilities.
- 1976 ○ Provide the public with regular updates on:
- 1977 – Which areas and buildings are to be evacuated, when the evacuation should
1978 begin, and how people should evacuate.
- 1979 – Which areas and buildings are no longer under a shelter-in-place
1980 recommendation or order.
- 1981 ○ Establish perimeter access controls around the affected evacuation area(s) utilizing
1982 traffic control points, barricades, and law enforcement personnel to deny access
1983 where appropriate.
- 1984 ○ Ensure designated access points are provided with up-to-date information on ongoing
1985 response activities that can be shared with individuals attempting to gain access to
1986 the evacuation area(s).

1987 **Activity 4.3: Conduct Search, Rescue, and Canvassing Operations**

- 1988 ■ **Conduct search and rescue:** Continue to conduct search and rescue operations³⁵ in radioactively
1989 contaminated zones. Search and rescue operations can be conducted in parallel with phased
1990 evacuations or be initiated in advance as part of lifesaving operations during the initial response.
1991 Prioritize these activities in areas that are most contaminated (e.g., the HZ), contain life-
1992 threatening hazards (e.g., structural instability or fires), or require technical rescue (e.g., vehicle
1993 extraction, confined space rescue, high angle rescue).
- 1994 ■ **Canvass the area:** Conduct a comprehensive canvassing operation of all buildings requiring
1995 evacuation within the contaminated area. This canvass can happen concurrent with or following
1996 evacuation:
- 1997 ○ Convene task forces to enter and clear buildings in order to identify people who need
1998 evacuation assistance, medical assistance, or are resistant to evacuation. Be
1999 cognizant of state and local laws and ordinances regarding evacuation orders; it may
2000 not be possible to require evacuation unless it is a declared state of emergency.

³⁵ Search and rescue operations to remove people from immediately dangerous situations should be conducted during the immediate response. However, there may be a need for additional search and rescue and urgent canvassing operations in the hot zone or other contaminated areas hours or days into the response if other hazards are present, such as a building collapse or fire.

- 2001 ○ Use emergency responders with hazmat or Hazardous Waste Operations and
2002 Emergency Response (HAZWOPER) training and appropriate PPE to conduct
2003 canvassing surveys in heavily contaminated areas, such as the hot zone.

- 2004 ○ If necessary, use non-HAZMAT-trained state and local government personnel to
2005 conduct canvassing in areas outside of the hot zone. As mentioned in Focus Area 2,
2006 these canvassers will require just-in-time radiation safety training, dosimetry, and a
2007 system for mitigating the spread of contamination.

- 2008 ○ Use remote-canvassing technology to assess compliance with evacuation operations,
2009 to reduce personnel time spent in contaminated areas. Examples include:
 - 2010 – Notification systems that allow for end-user feedback
 - 2011 – When remote telemetry is available, consider monitoring the usage of utilities
2012 such as telecommunications (internet services), power, and water usage
 - 2013 – Unmanned ground or aerial vehicles, or remote cameras



Recommended Resources:

- 2014

- 2015 ■ *Planning Considerations: Evacuation and Shelter-in-Place – Guidance for State, Local,*
2016 *Tribal and Territorial Partners.* (U.S. Department of Homeland Security, July 2019)
2017 [https://www.fema.gov/sites/default/files/2020-07/planning-considerations-evacuation-
and-shelter-in-place.pdf](https://www.fema.gov/sites/default/files/2020-07/planning-considerations-evacuation-
2018 and-shelter-in-place.pdf)

- 2019 ■ *Handbook for Responding to a Radiological Dispersal Device: First Responders Guide –*
2020 *The First 12 Hours.* (Conference of Radiation Control Program Directors, September 2006)
2021 [https://cdn.ymaws.com/www.crcpd.org/resource/resmgr/docs/rdd/rdd-handbook-
forweb.pdf](https://cdn.ymaws.com/www.crcpd.org/resource/resmgr/docs/rdd/rdd-handbook-
2022 forweb.pdf).

- 2023 ■ *Protective Action Guides and Planning Guidance for Radiological Incidents.* PAG Manual:
2024 EPA-400/R-17/001. (U.S. Environmental Protection Agency, Office of Radiation and Indoor
2025 Air, Radiation Protection Division, 2017.) [https://www.epa.gov/radiation/protective-action-
guides-pags](https://www.epa.gov/radiation/protective-action-
2026 guides-pags)

- 2027 ■ *Protective Action Area Map Templates.* EPA-420 (EPA, 2017)
2028 [https://www.epa.gov/sites/default/files/2017-
11/protective_action_area_map_templates_11202017_final_1.docx](https://www.epa.gov/sites/default/files/2017-
2029 11/protective_action_area_map_templates_11202017_final_1.docx)

2030

2031 Focus Area 5: Screen and Decontaminate

2032 **Guidance:** Provide early phase radiological screening and decontamination services for:

- 2033 ▪ responders including their equipment and vehicles;
- 2034 ▪ displaced and/or evacuating populations including special consideration of populations with
- 2035 disabilities and other access and functional needs and children or pregnant people, who are
- 2036 known to be more sensitive to the effects of radiation;
- 2037 ▪ any accompanying pets and service animals, privately owned vehicles, personal belongings, and
- 2038 medical equipment.

2039 As soon as possible, provide population monitoring services to screen, decontaminate, and track

2040 individuals who have been exposed to radiation or contamination or may require medical care at a

2041 later time. If resources allow, provide radiological screening and decontamination of additional

2042 personal belongings, medical equipment, or vehicles removed from contaminated areas after an

2043 initial evacuation and prior to re-entry and re-occupancy.



2044 Recommended Planning Partners:

- 2045 ▪ Emergency management
- 2046 ▪ Fire/HAZMAT teams
- 2047 ▪ Emergency Services
- 2048 ▪ Law enforcement
- 2049 ▪ State/Local Public health departments
- 2050 ▪ Local healthcare providers such as hospitals
- 2051 ▪ Environmental protection
- 2052 ▪ Radiation safety
- 2053 ▪ Medical examiners and coroners



2054 Key Terminology: CRC, Dosimetry, and Population Monitoring

2055 **Community Reception Center (CRC):** Locations/facilities designed to screen for radioactive

2056 contamination, decontaminate, and register people.

2057 **Dosimetry:** The science or technique of determining radiation dose. Strictly speaking, involving
2058 measured quantities, but also used informally to mean “dose assessment” (e.g., involving
2059 measurements and/or theoretical calculations).³⁶

2060 **Population Monitoring:** The process of evaluating and monitoring a population for radiologically
2061 related medical treatment, the presence of radioactive contamination on an individual’s
2062 clothing or body (external contamination), intake of radioactive materials (internal
2063 contamination), radiation dose received, resulting health risk, and long-term health effects.³⁷



2064 Key Terminology: Gross, Technical, and Self-Decontamination

2065 **Gross Decontamination:** Gross decontamination typically refers to non-targeted methods that
2066 remove large amounts of contamination, but may not ensure 100% removal, such as removing
2067 clothing and showering or hosing stations without run-off collection.

2068 **Technical Decontamination:** Decontamination designed to reduce contamination to very low
2069 levels, typically close to background radiation levels. This level of decontamination may not be
2070 necessary for all scenarios and requires radiation detection equipment to confirm the success
2071 of decontamination.

2072 **Self-Decontamination:** Decontamination carried out by individuals by themselves. Self-
2073 decontamination could include removal of outer layers of clothing, showering, or other
2074 methods.

2075 Introduction

2076 In the context of RDD incidents, screening refers to assessing people and objects for radioactive
2077 contamination. There are a variety of screening methods, each requiring different resources, training,
2078 and expertise. Screening methods may change throughout the response, based on resource
2079 availability and the goal of the decontamination effort (e.g., gross decontamination early in the
2080 incident versus technical decontamination later in the incident). When available, screening can be
2081 conducted with specialized instrumentation, such as portal monitors³⁸ to maximize screening
2082 throughput and handheld instruments, to pinpoint contamination. All of the activities in this focus
2083 area build off of activities already started in the *First 100 Minutes Guidance*, including setup of
2084 screening and decontamination for responders and for populations in contaminated areas.

³⁶ Derived from NCRP (2017) “Report No. 179, Guidance for Emergency Response Dosimetry”, and reprinted with permission of the National Council on Radiation Protection and Measurements. Available online at: <https://ncrponline.org/shop/reports/report-no-179-guidance-for-emergency-response-dosimetry-2017/>

³⁷ Derived from CDC (2014) *Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health Planners, 2nd edition*. Available online at: <https://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf>

³⁸ Portal monitors are radiation detection devices used for the screening of individuals, vehicles, or objects, and are typically shaped as doorways to screen the entire object or person.

2085 Decontamination is the process of removing radioactive contamination from a person or object. Like
2086 screening, decontamination method selection depends on resource availability. Decontamination
2087 methods include the use of wet wipes, dry brushing, showers, and vacuums to remove
2088 contamination from people and objects. In the absence of appropriate resources and/or time to
2089 conduct thorough decontamination (such as for people rapidly evacuating contaminated areas),
2090 changing outer clothing can dramatically and rapidly reduce contamination.³⁹

2091 **Containment of Wastewater from Decontamination**

2092 During the early response, guidance from the EPA allows emergency responders to release
2093 contaminated water from decontamination activities directly into the environment.⁴⁰ However,
2094 once all imminent threats to human health and life are addressed, any contaminated water
2095 generated by decontamination should be captured and contained. As a result, emergency
2096 response staff should be prepared to capture or otherwise contain contaminated water during
2097 the intermediate and late phases of the response, as well as for the extent of recovery
2098 operations. Exactly when this capture of contaminated water or trash needs to begin will be
2099 dependent on the particulars of the incident and the resources available.

2100 Screening and decontamination methods also will vary based on the characteristics of the
2101 populations and objects being considered, the number of people and objects that are contaminated,
2102 and the goal of the decontamination effort. Jurisdictions should work with HAZMAT and radiation
2103 experts, including one or several ROSS cadre members, to develop the best decontamination
2104 approach using the resources available.

2105 Screening and decontamination methods tend to begin with self-decontamination, then progress to
2106 gross and technical decontamination. As described in the *First 100 Minutes Guidance*, during the
2107 early response, first responders will perform quick screening and dry decontamination of individuals
2108 at designated exits from the Hot Zone to the extent practical, without unduly slowing down the self-
2109 evacuation process.⁴¹ Priority during this period should be given to life safety and stabilizing the
2110 scene, as people self-evacuating from the affected area will be instructed to self-decontaminate
2111 when they reach their destination (and, therefore, should not need extensive support from first
2112 responders).

2113 Assisted screening and decontamination also will likely occur at other locations during the early
2114 response – such as at entry/exit points and/or temporary shelters – and these efforts may either be
2115 targeted at very specific populations or be provided ad hoc based on available gross
2116 decontamination capabilities (e.g., decontamination capabilities of local fire departments). Hospitals

³⁹ If changing clothing is not feasible, brushing or carefully shaking outer clothing may help remove significant amounts of contamination as well.

⁴⁰ EPA (2000) *First Responders' Environmental Liability Due to Mass Decontamination Runoff*. Available online at: <https://www.epa.gov/sites/default/files/2013-11/documents/onepage.pdf>.

⁴¹ Dry decontamination refers to decontamination methods that do not utilize water, such as brushing off people or use of decontamination wipes.

2117 also will need to establish screening and decontamination capability, but it should be reserved only
2118 for hospital staff and individuals requiring medical treatment. Contaminated individuals who do not
2119 require medical treatment should be either sent home to self-decontaminate or directed to a
2120 Community Reception Center (CRC), if established.

2121 In the intermediate and late response phases, screening and decontamination should be
2122 increasingly consolidated into mass screening/decontamination centers to best utilize available
2123 resources. The best practice for mass screening/decontamination is the CRC. CRCs should be
2124 established at pre-identified locations, whenever possible as the scenario permits. As more
2125 resources become available, decontamination will transition to the use of more technical
2126 decontamination procedures (showers, sinks), designed to reduce contamination as much as
2127 reasonably possible.

2128 Typically, screening and decontamination are done together, where screening is used to identify who
2129 requires decontamination and verify removal of radioactive material after decontamination.⁴² As a
2130 result, screening and decontamination are generally co-located. CRC site selection and layout, if not
2131 pre-identified during planning or the early response, should consider the population being screened.
2132 A non-exhaustive list of considerations is included below.

- 2133 ▪ Families should be kept together whenever possible. This consideration may be less important if
2134 populations are primarily from office buildings, prisons or other facilities or locations that
2135 primarily will have adult populations.
- 2136 ▪ CRCs must be prepared to accommodate people with disabilities and other access and
2137 functional needs in the receiving population. This consideration will include ensuring all
2138 processes can accommodate wheelchairs or other mobility devices, medical equipment (e.g.,
2139 portable oxygen containers), and service animals. Service animals should not be separated from
2140 their owners during the screening, decontamination, and registration process. Some populations
2141 may include a larger proportion of people requiring access and functional needs considerations,
2142 such as those evacuating from nursing homes or retirement communities.
- 2143 ▪ Sufficient parking or loading/unloading space must be provided for people arriving in private
2144 vehicles or by bus. If vehicles originate from contaminated areas, the CRC should establish
2145 appropriate vehicle screening and decontamination processes.
- 2146 ▪ The CRC should provide clean clothes and other resources following screening, decontamination,
2147 and registration if the population does not already have access to necessary resources. This
2148 consideration will be more important for socioeconomically disadvantaged populations or
2149 populations not arriving via personal vehicles.

2150 Population categories for radiation screening and decontamination purposes are listed below; this
2151 list is not intended to be comprehensive. (Note the monitoring, screening, and decontamination of

⁴² However, when no equipment is available for screening or nearly all people are likely contaminated, decontamination may be performed without screening.

2152 buildings and critical infrastructure facilities/systems are not covered in this section. These are
2153 addressed in Focus Area 6)

2154 **Screening and Decontamination Considerations: Populations**

2155 **Responders, Response Equipment and Response Vehicles**

2156 Response personnel, equipment, and vehicles must be screened and decontaminated
2157 throughout the incident response and recovery process anytime they leave the contaminated
2158 area, because they may be repeatedly exposed to contamination. Failure to do so may pose risks
2159 to responders and the public, as well as spread contamination.

2160 **The Public, Their Pets/Service Animals, and Other Belongings**

2161 ▪ **Immediate Evacuees:** Early in the response, screening and decontamination of the public will
2162 focus on populations that have been displaced by the incident after self-evacuating, either of
2163 their own volition or at the direction of authorities. Depending on the size and complexity of
2164 the incident, such populations may be screened and decontaminated multiple times. For
2165 instance, initial gross decontamination may take place at hazard zone entry/exit
2166 checkpoints. As people move out of contaminated areas, more thorough technical
2167 decontamination will occur at CRCs.

2168 ▪ **Phased Evacuees:** As the response continues, there may be phased evacuations of
2169 populations that were originally directed to shelter-in-place, producing a delayed group of
2170 evacuees for screening and, if necessary, decontamination. There also may be individuals
2171 who seek screening and decontamination despite not receiving official directions to do so.

2172 ▪ **People with Disabilities, Access and Functional Needs, and Other Special Populations:**
2173 Screening and decontamination procedures must be inclusive of the whole community.
2174 Populations that include people with mobility, sensory, intellectual, developmental, cognitive,
2175 or mental disabilities, as well as children, unaccompanied minors, transgender people,
2176 pregnant or nursing mothers, homeless people, and people who do not speak English are
2177 generally at greater risk because they may require assistance to follow and/or understand
2178 decontamination instructions.⁴³

2179 ▪ **Pets & Service or Support Animals:** The Americans with Disabilities Act of 1990 (ADA) and
2180 the Pets Evacuation and Transportation Standards (PETS) Act of 2006 enacted following
2181 Hurricane Katrina, requires state and local agencies to accommodate household pets and
2182 service animals (PSAs) in disaster planning. Real-world incident after action reports indicate
2183 that people are more compliant with evacuation and shelter orders when their pets are

⁴³ For more information on providing for access and functional needs, see CDC's toolkit:
<https://www.cdc.gov/orr/readiness/resources/publications/afntoolkit.htm>.

2184 accommodated.^{44,45,46} This consideration may be different for pets and service animals.
2185 Service animals should not be separated from their owners, but it may be necessary to
2186 separate pets to accommodate the scale of decontamination necessary. Beyond the legal
2187 requirements, screening and decontamination of pets and service or support animals by
2188 appropriately trained staff will also help mitigate the spread of contamination.

2189 **Medical equipment and personal belongings:** Responders should be prepared to manage a
2190 wide variety of personal belongings people will bring to decontamination facilities, including
2191 medical devices (e.g., wheelchairs and hearing aids), phones, religious items, wallets,
2192 identification, money, keys, and other items of monetary or emotional significance. Medical
2193 devices should be returned to owners as soon as is feasible. If resources are not available
2194 for staff to screen and decontaminate medical devices, it may be appropriate to provide
2195 instructions for owners to decontaminate critically life-saving equipment or to bag the
2196 equipment for later screening. Screening and decontamination will be required for all objects
2197 entering shelter facilities and exit contaminated areas (which may be much later in the
2198 response when personal property is retrieved).

2199 **Privately Owned Vehicles (POVs):** The public may use POVs for evacuation and reentry.
2200 Vehicle decontamination may be necessary depending on the type and level of
2201 contamination to mitigate the spread of contamination but should not restrict or inhibit
2202 evacuation from hazard zones.

2203 **Decedents**

2204 Decedents may be contaminated by radioactive material before or after death, so remains must
2205 be externally screened and decontaminated to protect medical examiners and coroners, as well
2206 as anyone who interacts with the decedents during funerals or other rituals. Additionally,
2207 cremation is not recommended for contaminated decedents, and burials must follow special
2208 protocols to prevent contamination spread.^{47, 48}

2209 Specific activities related to screening and decontamination are listed in Table 13 and discussed
2210 below. These activities largely represent extensions of activities started during the initial response,
2211 discussed in the *First 100 Minutes Guidance*, but include new aspects or considerations during the

⁴⁴ Emergency Planning Committee. (2016) *Capitol Region Hazardous Materials Response Plan. Prepared for Connecticut Division of Emergency Management and Homeland Security*. Available online at: <https://crocog.org/wp-content/uploads/2016/06/CR-HMERP-1.pdf>.

⁴⁵ CDC (2014) *Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health Planners, 2nd edition*. Available online at: <https://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf>.

⁴⁶ In addition to the ADA, the disability non-discrimination provisions of the Rehabilitation Act of 1973 would apply to recipients of federal financial assistance.

⁴⁷ FEMA (2022) *Planning Guidance for Response to a Nuclear Detonation, 3rd Edition*. Available online at: https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf.

⁴⁸ If a decedent can be fully decontaminated, there should be no restrictions regarding burial or other ritualized practices. In some cultures, death practices are highly structured and scheduled, so delays and complications should be avoided unless genuinely necessary.

2212 evolving response and recovery. Early activities from the *First 100 Minutes Guidance* are not
 2213 reproduced here, in consideration of brevity and readability.

2214 **Table 13: Summary of Focus Area 5 Activities**

	Activity	Phase
5.1	Screen and Decontaminate Responders and their Equipment	Early to Intermediate (Hours to Days to Weeks)
5.2	Consolidate Screening/Decontamination Activities and Provide Comprehensive Population Monitoring Services to the Public	Early to Intermediate (Days to Weeks)
5.3	Screen and Decontaminate Personal Belongings and Civilian Vehicles	Intermediate to Late (Weeks to Years)

2215 **Activity 5.1: Screen and Decontaminate Responders and Their Equipment**

- 2216 ■ Establish screening and decontamination stations at entry/exit checkpoints on the perimeter of
 2217 the contaminated area. These stations should be set up early in response and must be sustained
 2218 as long as radioactive contamination remains, likely throughout recovery.
 - 2219 ○ Screen and decontaminate responders periodically. While screening and
 2220 decontamination of first responders is an immediate necessity, it remains necessary
 2221 for the entirety of the response and recovery effort.
 - 2222 ○ As responders enter contaminated areas, they may become exposed to radiation,
 2223 and potentially contaminated with radioactive materials. They must be screened and
 2224 decontaminated when exiting contaminated areas to avoid the spread of
 2225 contamination and minimize potential health risks.
 - 2226 ○ Over time, radiation hazards will vary depending on the radioactive material involved
 2227 and the type of work being performed in contaminated areas. Consequently,
 2228 screening and decontamination methods and requirements may change throughout
 2229 response and recovery. For example, building demolition or waste removal may
 2230 generate more dust than search and rescue operations, requiring more thorough
 2231 screening and decontamination.
- 2232 ■ Screen and decontaminate response vehicles throughout response and recovery. Similar to
 2233 responder personnel, response vehicle screening and decontamination should be a component
 2234 of the earliest response efforts, if resources allow, and must be sustained beyond the immediate
 2235 response phase.
 - 2236 ○ Response vehicles, such as ambulances and police and fire vehicles, may be re-
 2237 contaminated by radioactive material as they continually re-enter the contaminated
 2238 area to conduct their missions. The screening and decontamination methods used

- 2239 for vehicles likely will change as the response evolves. For example, while initial
2240 screening and decontamination may cover the entire vehicle, later in the response,
2241 screening may be limited to special areas such as the wheels and undercarriage of
2242 the vehicle.
- 2243 ○ Before response vehicles return to normal service, response vehicles should undergo
2244 additional screening and decontamination if they are no longer part of the response
2245 or recovery effort. For instance, a waste transport vehicle or an ambulance may
2246 return to serving the community outside the contaminated area.
- 2247 ■ Choose screening and decontamination procedures based on the identified radionuclide. As
2248 mentioned in the RDD Incident Scenario Considerations section, screening and decontamination
2249 methods will vary depending on the particular radionuclides and the physical and chemical form
2250 of the radioactive material. Work with SMEs to identify appropriate methods based on the
2251 specifics of the incident.
- 2252 ■ Modify and adjust screening and decontamination procedures throughout incident response and
2253 recovery. This action will be informed by the evolution of the radiological hazards present and
2254 knowledge thereof, the availability of additional resources, and the progress made against
2255 established response and recovery objectives.
- 2256 ■ Screen and decontaminate decedents. This activity protects medical examiners and coroners, as
2257 well as anyone participating in funerary practices, and mitigates the longer-term environmental
2258 consequences of improperly buried contaminated human remains. For specific information
2259 regarding handling, screening, and decontaminating potentially contaminated decedents, please
2260 reference the decedent resources identified below.

2261  **Recommended Resources:**

2262 **Responders⁴⁹**

- 2263 ■ IAEA (2006) Manual for First Responders to a Radiological Emergency Preparedness and
2264 Response. Available online at: [https://www.iaea.org/publications/7606/manual-for-first-
2265 responders-to-a-radiological-emergency](https://www.iaea.org/publications/7606/manual-for-first-responders-to-a-radiological-emergency).

2266 **Response Equipment**

- 2267 ■ FEMA (2002) *Contamination Monitoring Guidance for Portable Radiation Instruments Used*
2268 *for Emergency Response*. Available online at: <https://remm.hhs.gov/FEMA-REP-22.pdf>.

⁴⁹ This focuses on responder-specific resources, but resources about screening and decontaminating the general population also apply to responders. Those resources can be found in Activities 5.2-5.4.

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Response Vehicles

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- EPA (2019) *Management and Disposal of Vehicles Following a Wide Area Incident: Literature Review and Stakeholder Workshop*. Available online at: https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=345827&Lab=NHSRC&fed_org_id=1253&subject=Homeland%20Security%20Research&view=desc&sortBy=pubDateYear&showCriteria=1&count=25&searchall=%27indoor%20outdoor%20decontamination.

2276

Decedents

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2278
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2281
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- Appendix F: Medical Resources, Table 33 Mortuary Examiner/Coroner Resources
- CDC (2021) *Guidelines for Handling Decedents Contaminated with Radioactive Materials*. Available online at: <https://www.cdc.gov/nceh/radiation/emergencies/pdf/radiation-decedent-guidelines.pdf>.
- NCRP (2008) *National Council on Radiation Protection and Measurements (NCRP) Report No. 161, Management of Persons Contaminated with Radionuclides*. Available online at: <https://ncrponline.org/publications/reports/ncrp-report-161/>.

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Activity 5.2: Consolidate Screening/Decontamination Activities and Provide Comprehensive Population Monitoring Services to the Public

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- Continue to amplify self-decontamination instructions to people who were within or near contaminated areas while mass screening/decontamination capabilities are established. Self-decontamination, as well as early screening and decontamination activities, are discussed in more detail in the *First 100 Minutes Guidance*.

2290



Key Terminology: Ad Hoc Screening and Decontamination

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Ad hoc screening and decontamination refer to the onsite and early screening and decontamination activities discussed in the *First 100 Minutes Guidance* as well as in Focus Area 4 (Evacuation). These screening and decontamination activities primarily exist to address early demand at or near the response and may rely entirely on gross decontamination. CRCs are designed to provide more services than ad hoc locations but take more time and resources to set up and operate.

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- Consolidate ad hoc screening and decontamination activities for the public into CRCs. Early in the response, a variety of screening and decontamination activities may be occurring at shelters for evacuees or healthcare facilities for patients that require immediate medical treatment.

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2301
2302

- If large populations are contaminated, evacuated, or otherwise require screening, CRCs represent the best practice for providing mass population screening and decontamination services because they allow for a consolidation of such services

- 2303 with very high throughput. The CDC has a simulation tool for CRCs called SimPLER
2304 (Simulation Program for Leveraging and Evaluating Resources) that allows planners
2305 to estimate throughput capacity, staffing needs, and potential planning
2306 bottlenecks.⁵⁰
- 2307 ○ If possible, locate CRCs at or near shelters or other disaster service locations.⁵¹ This
2308 strategy can help avoid the need to establish resource-intensive screening and
2309 decontamination resources at every individual disaster service site. It also will help
2310 avoid situations where contaminated people inadvertently enter clean areas (e.g., at
2311 shelters) and disrupt operations.
- 2312 – Disaster service locations, such as shelters, should still maintain the capability
2313 for precautionary screening and gross decontamination, if possible. These
2314 locations may encounter people who have not been screened at a CRC – either
2315 because CRCs are not yet operational, or because a contaminated individual
2316 bypassed the CRC (or any other location where screening/decontamination is
2317 occurring) and arrived directly to the disaster services location.⁵²
- 2318 ○ CRCs (and any other location where screening/decontamination occurs) will likely
2319 receive many pets and service animals and must be prepared to screen and
2320 decontaminate them.
- 2321 – Note that service animals, which includes dogs and miniature horses, should not
2322 be separated from their owners during screening or decontamination.
- 2323 – FEMA’s estimates show that cats and dogs are the most common household
2324 animals; federal guidance sets expectations for up to 50-65 pets for every 100
2325 people.⁵³
- 2326 ○ During the later stages of response and recovery, people may arrive with more pets,
2327 service animals, medical equipment, personal belongings, and vehicles than initial
2328 evacuees, because they have had additional time to prepare prior to evacuation. CRC
2329 operations. This additional demand may also require additional CRCs to be
2330 established, or an adjustment to CRC procedures to allow greater throughput at
2331 established facilities.

⁵⁰ SimPLER (Simulation Program for Leveraging and Evaluating Resources) can be accessed online at:
<https://ephtracking.cdc.gov/Applications/simPler/>.

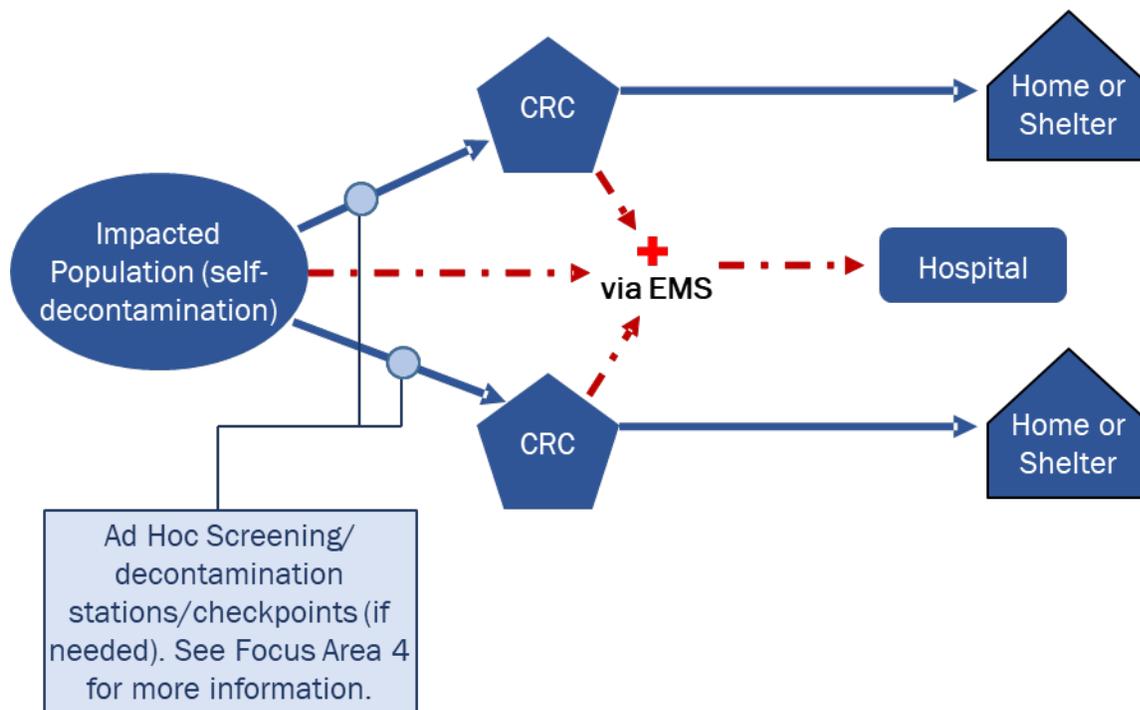
⁵¹ CDC (2014) Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health Planners, 2nd Edition. Available online at: <https://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf>.

⁵² See CDC guidance on operating shelters in radiological emergencies for more information on handling precautionary screening and decontamination: www.cdc.gov/nceh/radiation/emergencies/pdf/operating-public-shelters.pdf

⁵³ FEMA (2019) *Program Manual: Radiological Emergency Preparedness*. Available online at:
https://www.fema.gov/sites/default/files/2020-06/FEMA_REP_Program_Manual_Dec_2019.pdf

2332 ○ Localities should plan to establish several CRCs to accommodate the initial demand,
 2333 as there will be many people who would want to be screened even if they were not
 2334 near the incident site. Initial CRC operations should prioritize people who were in the
 2335 contaminated area; however, those who are concerned about contamination,
 2336 regardless of their risk or proximity to the incident, should not be dismissed or
 2337 stigmatized. Screening concerned populations may reduce anxiety for those
 2338 individuals and the community at large and may prevent them from gathering at
 2339 sensitive response locations, such as hospitals, command posts, or public buildings
 2340 in search of precautionary screening. Additionally, shelters, hotels, and other services
 2341 may require documentation showing screening or decontamination before admitting
 2342 displaced populations.

2343 ○ Figure 7 shows an ideal flow of contaminated individuals once screening and
 2344 decontamination activities have been consolidated into CRCs.



2345

2346 **Figure 7: Model of Ideal Population Flow to Consolidate Screening at CRCs**

2347 ■ Assess people for external contamination, internal contamination, and the need for medical
 2348 follow-up, also called **population monitoring**.

2349 ○ If possible, population monitoring activities should be consolidated into CRCs,
 2350 allowing CRCs to act as a one-stop service center for screening, decontamination,
 2351 and registration.

- 2352 ○ Depending on the specifics of the incident, population monitoring may require
2353 specialized equipment or expertise. Registration of all people who were in
2354 contaminated areas is important to allow follow-up at a later time. The CDC provides
2355 a free electronic tool, the CRC eTool, to simplify data collection at CRCs.⁵⁴
- 2356 – At a minimum, registration at a CRC should include name, contact information
2357 (cell phone, email) and location at the time of the incident. Collecting this
2358 information will allow public health officials to contact people who were located in
2359 contaminated areas for follow-up.
- 2360 ▪ Recommend or require that people who are seeking non-lifesaving disaster services (e.g.,
2361 disaster/assistance centers, family assistance centers, evacuation centers, shelters) first be
2362 screened for contamination at a CRC.
- 2363 ○ Radiation safety measures should be integrated with infection control, public safety,
2364 and other protocols detailed in all-hazards plans at any locations where potentially
2365 contaminated individuals may be seeking mass care services or resources. The CDC
2366 document, *A Guide to Operating Public Shelters in a Radiation Emergency* (linked
2367 below), provides more detail on incorporating screening and decontamination into a
2368 shelter operation.
- 2369 ○ As mentioned in Focus Area 4, if CRCs are not yet established while phased
2370 evacuations are ongoing, use of screening and decontamination stations or
2371 checkpoints along evacuation routes, or screening/decontamination capabilities
2372 deployed to shelter intake locations, may be appropriate. See Focus Area 4.



Recommended Resources:

CRC and Shelter Operations

- 2374
- 2375 ▪ CDC (2022) *CDC Community Reception Centers webpage (for the public)*. Available online
2376 at: <https://www.cdc.gov/nceh/radiation/emergencies/crcs.htm>.
- 2377 ▪ CDC (2022) *Population Monitoring, Community Reception Centers (CRC), and Shelter*
2378 *Resources for Radiation Emergencies (for responders)*. Available online at:
2379 <https://www.cdc.gov/nceh/radiation/emergencies/populationmonitoring.htm>.
- 2380 ▪ CDC (2023) *Radiation Emergencies: What to Expect at a Community Reception Center*
2381 *(CRC)*. Available online at: https://www.cdc.gov/nceh/radiation/emergencies/crcs_ld.htm.

⁵⁴ The CDC Community Reception Center Electronic Data Collection Tool (CRC eTool) can be found online at: <https://www.cdc.gov/nceh/radiation/emergencies/crcetool.htm>

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- 2383
- CDC (2021) *SimPLER (Simulation Program for Leveraging and Evaluating Resources)*. Available online at: <https://ephtracking.cdc.gov/Applications/simPler/>.
- 2384
- 2385- CDC (2023) *This is a T.E.S.T. CRC, A Tabletop Exercise Simulation Tool*. Available online at: <https://www.cdc.gov/nceh/radiation/emergencies/training/crcetest.htm>.

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2387- CDC (2015) *A Guide to Operating Public Shelters in a Radiation Emergency*. Available online at: www.cdc.gov/nceh/radiation/emergencies/pdf/operating-public-shelters.pdf.

2388

2389- FEMA (2022) *Planning Guidance for Response to a Nuclear Detonation - Appendix 5.2: Strategies for Screening and Decontaminating People*:
2390 [https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-](https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf)
2391 [guide.pdf](https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf).

2392

2393- CDC (2018) *Community Reception Center Electronic Data Collection Tool (CRC eTool)*. Available online at: <https://www.cdc.gov/nceh/radiation/emergencies/crcetool.htm>.

2394 **Population Monitoring:**

- 2395
- 2396
- 2397- CDC (2014) *Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health Planners*. Available online at:
www.cdc.gov/nceh/radiation/emergencies/pdf/population-monitoring-guide.pdf.

2398

2399- REMM (2023) *Population Monitoring After Radiation Emergencies*. Available online at:
<https://remm.hhs.gov/surveillance.htm>.

2400 **Screening and Decontamination of Pets & Service Animals**

2401 Published guidance for screening household pets and animals following RN disasters is quite
2402 limited, but the following resources provide some high-level information:

- 2403
- 2404
- 2405- CDC (2014) *Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health Planners*. Available online at:
<https://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf>.

2406

2407- REMM (2023) *Veterinarians: Information for Radiation Emergencies*. Available online at:
https://remm.hhs.gov/remm_PetOwners.htm.

2408

2409

2410- CDC (2018) *Decontamination – Pets*. Available online at:
[https://www.cdc.gov/nceh/radiation/emergencies/selfdecon_pets.htm?CDC_AA_refVal=ht](https://www.cdc.gov/nceh/radiation/emergencies/selfdecon_pets.htm?CDC_AA_refVal=https%3A%2F%2Femergency.cdc.gov%2Fradiation%2Fselfdecon_pets.asp)
[tps%3A%2F%2Femergency.cdc.gov%2Fradiation%2Fselfdecon_pets.asp](https://www.cdc.gov/nceh/radiation/emergencies/selfdecon_pets.htm?CDC_AA_refVal=https%3A%2F%2Femergency.cdc.gov%2Fradiation%2Fselfdecon_pets.asp).

2411

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2414- FEMA (2022) *Planning Guidance for Response to a Nuclear Detonation - Appendix 5.3: Screening and Decontamination Service Animals and Pets*. Available online at:
[https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-](https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf)
[guide.pdf](https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf).

2415 **Activity 5.3: Screen and Decontaminate Personal Belongings and Civilian**
2416 **Vehicles Removed from Contaminated Areas**

- 2417 ▪ Monitor established entry and exit points to screen and decontaminate objects and mitigate the
2418 spread of contamination and protect people from prolonged contamination exposure.
- 2419 ○ Before areas are reoccupied, people may have an opportunity to reenter and reclaim
2420 property, vehicles, and belongings left behind in contaminated areas (including
2421 residential and commercial areas). Screening and decontamination associated with
2422 retrieval of such items should be coordinated with remediation and reopening
2423 activities (Focus Areas 7 & 9, respectively) and will occur before contaminated areas
2424 are fully remediated or reopened.
- 2425 ○ Hazard zone entry and exit points should have screening equipment capable of
2426 accommodating a wide range of objects, including instruments such as portal
2427 monitors for vehicles and personnel, as well as pancake probes.⁵⁵ If removable
2428 contamination is anticipated, wipe sampling may be appropriate as well.
- 2429 – Screening levels should be developed for different types and sizes of objects
2430 depending on how they are used. For example, stuffed animals may require
2431 stricter screening levels, since children may rub them on their face or sleep with
2432 them in their beds. By contrast, photo albums may have higher screening levels
2433 as they are handled less frequently, and users spend less time in close proximity
2434 to them. Regardless, all screening levels should be designed for unrestricted
2435 release if possible (e.g., contamination is low enough that the item can be used
2436 or disposed of with minimal or no further controls or restrictions).⁵⁶
- 2437 ○ Decontamination methods should be similarly designed to handle a wide range of
2438 objects, including a combination of wet decontamination (for plastic, metal, or other
2439 objects) and dry decontamination methods (such as dry wipes or vacuums). Most
2440 appropriate decontamination methods are dependent on both the radioactive
2441 material and the object being decontaminated.
- 2442 – People are likely to retrieve belongings with significant monetary or sentimental
2443 value (e.g., stuffed animals, photo albums, signed sports paraphernalia or other
2444 collectors' items, family heirlooms, etc.), which may be fragile or damaged by
2445 certain decontamination methods.
- 2446 ○ A process for handling items that cannot be sufficiently decontaminated should be
2447 developed ahead of time. While it is possible that insurance or disaster assistance

⁵⁵ Pancake probes are popular hand-held radiation detectors, with flat circular components that resemble pancakes.

⁵⁶ IAEA (1992) *Monitoring Programmes for Unrestricted Release Related to Decommissioning of Nuclear Facilities*. Available online at: https://inis.iaea.org/collection/NCLCollectionStore/_Public/23/075/23075816.pdf.

2448 may cover items of monetary value that cannot be sufficiently decontaminated,
2449 sentimental items will need a separate process (e.g., restricted release with special
2450 handling instructions or extended storage to allow radioactivity to decay).



Recommended Resources:

2452 **Personal Belongings**

- 2453 ▪ NUSTL (2017) *Using Preventative Radiological Nuclear Detection Equipment for*
2454 *Consequence Management Missions*. Available online at:
2455 [https://www.dhs.gov/publication/st-frg-using-preventative-radiological-nuclear-detection-](https://www.dhs.gov/publication/st-frg-using-preventative-radiological-nuclear-detection-equipment-consequence)
2456 [equipment-consequence](https://www.dhs.gov/publication/st-frg-using-preventative-radiological-nuclear-detection-equipment-consequence).
- 2457 ▪ FEMA (2002) *REP-22: Contamination Monitoring Guidance for Portable Instruments Used*
2458 *for Radiological Emergency Response to Nuclear Power Plant Accidents*. Available online
2459 at: <https://remm.hhs.gov/FEMA-REP-22.pdf>.

2460 **Vehicles** (additional vehicle guidance is included with response equipment resources in 5.1)

- 2461 ▪ FEMA (2023) *Planning Guidance for Response to a Nuclear Detonation – Appendix 5.4:*
2462 *Handling Contaminated Vehicles*. Available online at:
2463 [https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-](https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf)
2464 [guide.pdf](https://www.fema.gov/sites/default/files/documents/fema_nuc-detonation-planning-guide.pdf).

2465

Strategy 4: Restore the Environment

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Focus Area 6: Restore and Sustain Critical Infrastructure and Select Buildings

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***Guidance:** Implement a process to restore critical infrastructure (CI) select residential or commercial buildings impacted by blast effects and/or radiation contamination to bring the vital services they provide back on-line and prevent them from degrading while radiation remediation activities are completed. Successful restoration and sustainment require comprehensive data collection about the status of impacted CI and buildings and the need for decontamination, restoration, ongoing maintenance, and sustainment of other critical services. It will also require close coordination with law enforcement and diverse restoration and maintenance teams (e.g., plumbing, electrical, pest control) and utility workers operating under appropriate radiological safety guidelines.*

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Recommended Planning Partners:

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- Emergency management

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- Public works

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- Civil engineering

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- Utilities/infrastructure owners/operators

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- Environmental protection

2482

- Radiation control

2483

- Law enforcement

2484

- Fire/HAZMAT teams

2485



Key Terminology: Critical Infrastructure, Restoration, and Sustainment

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Critical Infrastructure (CI) includes facilities, systems, and networks that provide key services to the public and are vital to public health and safety, such as transportation systems, telecommunications infrastructure, hospitals and medical facilities, power plants, and emergency services, among others.

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Restoration includes the repair of CI or commercial or residential buildings to bring them back to a state where they can function normally. This includes, for example, repairing blast damage to buildings from an explosive RDD or fixing damaged cell tower equipment to restore cell service in impacted areas.

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2493

2494 **Sustainment** is the provision of services, logistics, maintenance, financial management,
2495 personnel services, interconnected utility, and health service support necessary to maintain CI
2496 and select residential or commercial buildings until contaminated areas are successfully
2497 remediated and reoccupied.

2498 Introduction

2499 The remediation process for cleaning up the contaminated area, including damaged and/or
2500 radiologically contaminated CI assets and systems and select residential and commercial buildings,
2501 could extend for weeks, months, or years depending on the nature of the incident. For this reason, a
2502 critical component of any radiological response and recovery plan includes restoration and
2503 sustainment of CI assets and systems that are critical to the response, including human health and
2504 safety, transportation of evacuees, etc., as well as commercial and residential structures that will
2505 need to be able to accommodate the return of displaced people once remediation activities are
2506 successfully completed. Returning CI to normal functionality quickly is important not only to facilitate
2507 the response and address critical health and safety needs but also the safe return of evacuees into
2508 remediated areas.

2509 CI restoration and sustainment are important, since successful, safe, and timely remediation of
2510 contaminated areas will require functioning power, water, sewer, heat, transportation, and
2511 telecommunications services. In addition, CI systems often are part of extended networks that
2512 support a larger geographic area. Delays in restoration of damaged or contaminated CI or allowing
2513 key aspects of critical systems to deteriorate during the response and recovery effort likely will
2514 generate significant cascading effects beyond those areas immediately impacted by an RDD
2515 incident. For example, a drinking water aqueduct that passes through a highly contaminated area
2516 will need to be maintained so that uncontaminated areas served by the aqueduct can maintain
2517 water service and contaminated areas that are cleaned up on an earlier timetable can be more
2518 promptly reoccupied.

2519 CI and select commercial and residential buildings will require continuous maintenance, repair, and
2520 upgrades to remain functional and prevent degradation to support eventual re-use/re-occupation.
2521 Failure to sustain affected CI and priority buildings may adversely impact the reoccupation timeline
2522 or result in expensive or even cost-prohibitive remediation for issues such as mold or pests that are
2523 unrelated to radioactive contamination.



2524 Coordination Opportunity: Radiological Emergency Response Team (RERT)

2525 [Radiological Emergency Response Team \(RERT\)](#), an EPA asset, can provide technical advice
2526 and assistance including radiological assessment and monitoring, public messaging, and risk
2527 assessment.

2528 **Table 14: Summary of Focus Area 6 Activities**

	Activity	Phase
6.1	Gather Information on Impacted Critical Infrastructure and Select Buildings	Intermediate to Late (Days to Weeks)
6.2	Decontaminate Critical Infrastructure and Select Buildings	Intermediate to Late (Days to Months)
6.3	Establish Restoration/Sustainment Task Forces	Intermediate to Late (Weeks to Years)
6.4	Conduct Restoration/Sustainment Operations	Intermediate to Late (Months to Years)

2529 **Activity 6.1: Gather Information on Impacted Critical Infrastructure and Select**
 2530 **Buildings**

- 2531
- 2532 ▪ Identify and document information on CI facilities/systems and select buildings in the
 2533 contaminated area using the checklist provided below. To the extent possible, leverage available
 2534 remote technologies and quickly accessible resources, such as government records, GIS
 2535 databases, and subject matter expertise from agency partners (e.g., jurisdictional planning
 departments and utility owners/operators).

Example Building/Infrastructure Information to Gather and Verify

- 2537 ▪ Type of infrastructure and services provided (e.g., electrical, water, sewage, natural or
 2538 compressed gas systems) along with number of customers supported
- 2539 ▪ Category/use associated with each building/infrastructure (e.g., residential,
 2540 industrial/commercial, healthcare facility)
- 2541 ▪ Criticality of the building/infrastructure to community lifelines stabilization, including services
 2542 provided to other interconnected CI
- 2543 ▪ Number and type of staff employed
- 2544 ▪ Characteristics of building construction (e.g., brick vs wood frame), HVAC system, and
 2545 supporting utilities
- 2546 ▪ CI/building management/owner contact information
- 2547 ▪ Owner and tenant contact information (for both commercial and residential properties)
- 2548 ▪ Contact information for security, maintenance, and janitorial personnel
- 2549 ▪ Hazardous materials stored on-site and their locations

- 2550 ▪ Building/facility blueprints, including any remodeling or construction underway or recently
2551 completed, square footage, and layout (including number and types of rooms)
- 2552 ▪ Ways to access the property, including keys, proximity cards, security cards, passwords, and
2553 biometric systems
- 2554 ▪ Information on accessing and operating building systems, including HVAC, fire alarms and
2555 suppression systems, security systems, elevators, internal communication systems, and
2556 information technology infrastructure
- 2557 ▪ Unique features about the structure that could facilitate remediation activities, such as a
2558 helipad, loading dock, or parking structure
- 2559 ▪ Valuables stored or other specialized items on-site: (e.g., money, pharmaceuticals, firearms,
2560 etc.) that may require relocation or extra security measures
- 2561 ▪ Other hazards or concerns not listed
- 2562 ▪ Surrounding community demographics (e.g., population numbers and vulnerable populations
2563 served)
- 2564 ▪ Interview CI and building owners and operators to obtain information regarding the function of
2565 the infrastructure system and any hazards or operational concerns that may exist if maintenance
2566 is not conducted. CI may be owned and operated by a government agency (city, county, state or
2567 federal) or by private industry.
- 2568 ▪ Utilize CI and building information gathered to inform remediation priorities (See Focus Area 7).
- 2569 ▪ Establish a single database where CI and building information can be consolidated to facilitate
2570 long-term tracking and information management.



2571 Planning Tip: Leverage Remote Resources

- 2572 The property information obtained from owners, managers, and tenants may not be a complete
2573 record for all the properties involved. To minimize exposure to workers, leverage remotely
2574 accessible resources to the greatest extent possible. These resources may include:
- 2575 ▪ Municipal government records and databases (e.g., first responder, civil engineering,
2576 environmental protection, and planning departments)
 - 2577 ▪ Social media and commercial news
 - 2578 ▪ Commercial and government satellite images and personal photos taken of the area prior
2579 to the incident
- 2580 ▪ Dispatch teams to verify on-scene infrastructure damage and operating conditions if key
2581 information is missing or requires on-site verification. To limit exposure time, teams should
2582 conduct damage assessments from a vehicle or use remotely accessed resources (e.g.,

2583 unmanned systems and camera feeds) where possible. Damage assessments should be
2584 planned and conducted with support from the Radiation/Safety Officer. Assessment personnel
2585 should have received appropriate radiation safety training and be outfitted with appropriate PPE
2586 prior to initiation of assessment activities. In addition to verifying information, on-site damage
2587 assessments can be used to identify:

2588 ○ Issues and hazards that require immediate attention, such as downed power lines,
2589 water leaks, gas leaks, or ruptured sewer lines

2590 ○ Evidence of unauthorized entry such as theft, vandalism, or squatting

2591 ○ Unsecured property, buildings and CI

2592 ○ Damage to CI and select buildings along with potential cascading impacts

2593 ○ Chemical or radiological hazards (e.g., stored hazardous materials such as chlorine
2594 inside buildings or in the proximity of CI)

2595 ○ Potential access problems for remediation workers (including abandoned vehicles
2596 that may be blocking key access points)

2597 ■ Obtain permission from owners, operators, and tenants to allow access to private property to
2598 enable the conduct of remediation operations and related activities. Contingencies should also
2599 be put in place to enable the timely abatement or condemnation of property that has been
2600 abandoned or is deemed too unsafe to remediate.

2601 ■ Obtain permission from law enforcement officials to access areas designated as crime scenes or
2602 as restricted access areas.

2603 ○ Coordination should take place with law enforcement to ensure that areas that had
2604 been designated as crime scenes or as restricted access areas can be accessed for
2605 restoration and sustainment operations.

2606 ○ Evidence collection within the area designated as the crime scene likely will need to
2607 be completed before restoration operations can begin.

2608 **Activity 6.2: Decontaminate Critical Infrastructure and Select Buildings**

2609 ■ Identify CI and buildings essential to support response and recovery operations that require early
2610 decontamination to maintain operating status. Priority decontamination of CI and other select
2611 buildings will reduce hazards and allow for safer access to perform maintenance or sustain
2612 operations while remediation is underway.

- 2613 ○ Consider both CI facilities/systems, such as water and electrical systems, and
2614 buildings, such as emergency operations centers, hospitals, and fire/police stations,
2615 when determining CI priorities for decontamination,

- 2616 ■ Consider alternatives to decontamination for each identified CI or select building. Alternatives
2617 may include reduced staffing and maintenance schedules, remote operation of critical functions,
2618 moving infrastructure service load to unaffected equipment, or using alternate sites to house
2619 critical functions.

- 2620 ■ Determine current contamination levels at locations where restoration/maintenance crews will
2621 be operating to decontaminate identified CI and select buildings. Follow appropriate dose rate
2622 guidelines during the decontamination process (See Focus Area 2 for more information).

- 2623 ■ Consider the scalability of decontamination methods and the size and priority of the
2624 infrastructure that requires decontamination. Like other decontamination activities,
2625 decontamination methods for CI and select buildings depend on the area impacted, radionuclide
2626 involved, and decontamination resources available. Note that fully qualified, specialized
2627 decontamination staff may not be available to support such decontamination efforts until further
2628 into the response, leaving first responders with just-in-time training to conduct the initial gross
2629 decontamination.⁵⁷



2630 Recommended Resources: Radionuclide-Specific Guidance and Resources

- 2631 Federal best practices and other literature describe clean-up efforts that can be tailored to the
2632 incident based on the involved radionuclide(s) and surface materials:
- 2633 ■ EPA’s Radiological Decontamination Query Tool provides a comparison of methods that
2634 could be used for cleanup.

 - 2635 ■ Joint Chiefs of Staff (2006). CBRN Decontamination: Multiservice Tactics, Techniques, and
2636 Procedures for Chemical, Biological, Radiological, and Nuclear Decontamination.

 - 2637 ■ EPA (2016). Current and Emerging Post-Fukushima Technologies, and Techniques, and
2638 Practices for Wide Area Radiological Survey, Remediation, and Waste Management.
2639 Washington, DC.

2640 Activity 6.3: Establish Restoration/Sustainment Task Forces

- 2641 ■ Convene operational task forces to conduct restoration and sustainment operations for each
2642 building or a group of buildings, as well as CI, identified in Activity 6.1 above. The sustainment
2643 task force core teams should develop a sustainment plan for each building, group of buildings, or

⁵⁷ FEMA 2022 Planning Guidance for Response to a Nuclear Detonation – Appendix 2.2

- 2644 CI they are responsible for which they can subsequently use to create missions, tasks, and
2645 assignments.
- 2646 ■ Identify qualified members of the sustainment task force. For commercial high-rise and industrial
2647 buildings, a range of skills will be needed to safely inspect, provide maintenance, and conduct
2648 repairs and other restoration activities. For CI systems, specially trained and qualified personnel
2649 will be required. Each task force should:
- 2650 ○ Have a core team that can track restoration/sustainment needs for their assigned CI
2651 facilities/systems and select buildings over time and conduct inspections to monitor
2652 their conditions.
- 2653 ○ Be fully qualified to access and perform restoration, repair, and/or maintenance on
2654 the specific infrastructure system or building to which they are assigned.
- 2655 ○ Be equipped to call upon specialized resources to conduct restoration and sustained
2656 maintenance, dependent on the specifics of the select building or CI facility/system
2657 in question. The blue box below lists the types of disciplines that may be needed to
2658 support sustainment task forces.
- 2659 ■ Provide training so that task forces and other specialized resources may safely operate in the
2660 contaminated area.
- 2661 ○ A Radiation Health and Safety Officer (RHSO) should be consulted as part of each
2662 operation to determine the level of training needed, permissible length of operations
2663 in the contaminated area, and PPE and dosimeters required for the tasks being
2664 performed.
- 2665 – Ideally, several RHSOs would be integrated into the response to provide thorough
2666 oversight into activities involving the potential for radiation exposure. However, if
2667 there are insufficient RHSOs available, an acceptable alternative would be to
2668 utilize safety officers to fill most positions with RHSO(s) providing necessary
2669 oversight.
- 2670 ○ Planners should assume occupational radiation safety training will be necessary and
2671 identify appropriate training materials and qualified instructors ahead of time.
- 2672 ○ Ensure all personnel entering the established perimeters are properly trained in
2673 radiation safety, have appropriate PPE and dosimeters, are aware of dosage and
2674 stay-time limits and are included in a dosimetry monitoring program.

Sustainment Task Force

Core Team

- Audio, visual, and digital mapping team

- 2678 ▪ Incident Command System (ICS) trained personnel
- 2679 ▪ Property tracking/data collection team
- 2680 ▪ Safety officer
- 2681 ▪ Structural engineer
- 2682 ▪ Systems Engineer
- 2683 ▪ RHSO (a general safety officer with a RHSO available as reach back is a sufficient
- 2684 alternative)

2685 Specialized Resources

- 2686 ▪ Animal control officer
- 2687 ▪ Building system expert (could involve HVAC, water, security systems, fire alarm, etc.)
- 2688 ▪ Carpenter
- 2689 ▪ Commercial IT systems expert
- 2690 ▪ Electrician
- 2691 ▪ Elevator repair
- 2692 ▪ Hazardous materials specialist
- 2693 ▪ Locksmith
- 2694 ▪ Pest control worker
- 2695 ▪ Plumber
- 2696 ▪ Tow truck operator

2697 **Activity 6.4: Conduct Restoration/Sustainment Operations**

- 2698 ▪ Restoration/sustainment operations should be initiated as soon as the area has been secured,
- 2699 radioactive contamination has been measured and mapped, and sustainment task force workers
- 2700 have been provided radiation safety training, dosimeters, and PPE, as required.

- 2701 ▪ Restoration/sustainment operations should be continued as resources permit until operational
- 2702 functionality has been restored, as long as conditions on site can safely support such a tempo.
- 2703 Once a CI facility/system or select building has been assessed and decontamination and/or
- 2704 major repairs have been completed, efforts should shift to a focus on longer-term operations,
- 2705 sustainment, and periodic checks and maintenance.

- 2706 ▪ Direct initial restoration/sustainment efforts toward mitigating further damage due to immediate
- 2707 or potential hazards, followed by a systematic, methodical approach for maintenance, repair, and
- 2708 upgrades based on established incident priorities and operational objectives. Initial
- 2709 restoration/sustainment efforts may include:

- 2710 ○ Assessing a building/structure's physical integrity
- 2711 ○ Determine if other hazardous conditions exist
- 2712 ○ Testing and running (where appropriate) critical systems such as HVAC, plumbing,
2713 and electricity
- 2714 ○ Assessing functionality of CI such as electrical substations, telephone and internet
2715 routing systems, and other utilities
- 2716 ○ Conducting preventative maintenance or repair to CI and select buildings Securing
2717 access to buildings and CI
- 2718 ○ Deploying rodent and pest control measures
- 2719 ■ Utilize FEMA's standard search and rescue marking system⁵⁸ and Post-disaster Building Safety
2720 Evaluation Guidance⁵⁹ to summarize the physical condition of CI facilities/systems or buildings.
2721 These systems are used to rapidly track search and rescue operations, mark searched buildings,
2722 identify hazards present and classify the conditions of buildings. Consider taking additional
2723 measurements or photographs/videos of areas or unique features that may require special focus
2724 or treatment to achieve sustainment and remediation. As part of the assessment, take
2725 automated digital measurements and videos of the entire interior, as the situation permits. This
2726 data adds to the analysis and plan for remediation described in Focus Area 7.

2727  Recommended Resources: CI Restoration and Recovery

- 2728 ■ FEMA (2019) National Response Framework, 4th Ed.
2729 https://www.fema.gov/sites/default/files/2020-04/NRF_FINALApproved_2011028.pdf
- 2730 ■ FEMA (2008) Critical Infrastructure and Key Resources Support Annex to the NRF.
2731 <https://www.fema.gov/pdf/emergency/nrf/nrf-support-cikr.pdf>
- 2732 ■ FEMA (2016) National Disaster Recovery Framework, 2nd Ed.
2733 [https://www.fema.gov/sites/default/files/2020-](https://www.fema.gov/sites/default/files/2020-06/national_disaster_recovery_framework_2nd.pdf)
2734 [06/national_disaster_recovery_framework_2nd.pdf](https://www.fema.gov/sites/default/files/2020-06/national_disaster_recovery_framework_2nd.pdf)

2735

⁵⁸ FEMA (2013) *National Urban Search and Rescue Response System Marking Standards Handbook*.

⁵⁹ FEMA (2019) *P-2055, Post-disaster Building Safety Evaluation Guidance – Report on the Current State of Practice, including Recommendations Related to Structural and Nonstructural Safety and Habitability*. Available online at: https://www.fema.gov/sites/default/files/2020-07/fema_p-2055_post-disaster_buildingsafety_evaluation_2019.pdf

2736 Focus Area 7: Remediate

2737 **Guidance:** Execute the Optimization Process to define cleanup levels, remediation zones, and
2738 engage with key stakeholders. Develop remediation plans and perform remediation/clean-up. Verify
2739 clean-up levels are met and release the area/site for reuse.



2740 Recommended Planning Partners:

- 2741 ▪ Admin/finance
- 2742 ▪ Emergency management
- 2743 ▪ Environmental protection
- 2744 ▪ Public health
- 2745 ▪ Occupational health and safety
- 2746 ▪ Public works
- 2747 ▪ Hazardous materials remediation experts
- 2748 ▪ Urban planners/zoning managers
- 2749 ▪ Transportation specialists
- 2750 ▪ Public/private partnerships
- 2751 ▪ Radiation subject matter experts

2752 Introduction

2753 The goal (or objective) of **remediation** is to reduce contamination to a level at which radiation
2754 exposure risk to people is low enough to open and release an area for re-occupancy for current and
2755 planned future uses. In some instances, it may not be feasible to remediate to a level where an area
2756 may be released for unrestricted use. In these cases, remediation may be conducted to reduce
2757 exposure risk to a level where specific activities can resume with minimal restrictions and/or
2758 protective actions. This focus area outlines the major steps necessary to begin the process for
2759 medium- to long-term remediation activities.



2760 Key Terminology: Remediation

2761 **Remediation** refers to the activities performed to remove/clean-up contamination based on
2762 metrics and targets established using the Optimization Process.

2763 For even a minor release of radioactive material, the remediation process may require significant
2764 time (months to years) and resources to complete. These requirements will be influenced by a
2765 combination of factors including, but not limited to:

- 2766 ▪ Type of contamination (isotopes, half-life, physical/chemical form)
- 2767 ▪ Desired speed of remediation,
- 2768 ▪ Total size of area requiring remediation,
- 2769 ▪ Complexity of the built environment and characteristics of the area (e.g., a park, a sidewalk, a
2770 store, a residential building, a critical infrastructure facility, etc.),
- 2771 ▪ Impacted population,
- 2772 ▪ Selected cleanup level,
- 2773 ▪ Public acceptance of the cleanup level decision,
- 2774 ▪ Technical feasibility of decontamination methods available, and
- 2775 ▪ Social factors such as economic and equity considerations.

2776 To manage the complexity and resource intensiveness of the remediation process, planners should
2777 understand and ensure their plan accounts for these important factors. See Strategy 4 Table 30 in
2778 Annex B for additional information on data sources used to inform remediation planning.

2779 Wide area radiological remediation is likely beyond the capabilities of any one state or Federal
2780 agency and be a joint effort of all of government including Federal and STTL government. It will also
2781 involve NGOs, the private sector including expertise from the nuclear and environmental cleanup
2782 industries, and expertise from academia. Many states and several Federal agencies, including but
2783 not limited to EPA, USACE, USCG have remediation expertise and remediation contract support
2784 including contracts to support remediation planning and design and contracts to perform
2785 remediation. GSA also has contracts that can support remediation planning and design and to
2786 perform remediation. For an incident where there is widespread contamination over many square
2787 miles, it is likely that all levels of government and the private sector will support remediation. If
2788 jurisdictions are pursuing remediation independently, they might consider:

- 2789 ▪ Procure contract support for planning and designing remediation within their jurisdiction.
2790 Procure remediation contract support for implementing remediation plans. Typically, these
2791 should be different contractors to avoid a conflict of interest.
- 2792 ▪ Determine if contractors under consideration specialize in specific remediation activities. For
2793 example, one contractor might be skilled at managing large, sprawling jobs with many sub-
2794 contracts, while another might be proficient at managing the waste component of a larger

2795 remediation job. These factors should be taken into consideration when determining how
2796 multiple contractors work together or sub-contract.

2797 ■ At a minimum, lead contractors should have experience in environmental cleanup, including
2798 radiologically experience.

2799 ■ Jurisdictions may also consider permitting and vetting processes to provide a central list of
2800 private contractors for public use, such as on private property. Similar to other types of disasters,
2801 if a list of contractors is provided, care must be taken to comply with state and federal law
2802 related to government endorsement of (and competition among) contractors, as well as
2803 restrictions on the utilization of certain entities (such as debarment and suspension).

2804  **Key Terminology: Optimization**

2805 The International Commission on Radiological Protection defines Optimization as “The source-
2806 related process to keep the magnitude of individual doses, the number of people exposed, and
2807 the likelihood of potential exposure as low as reasonably achievable below the appropriate
2808 dose constraints, with economic and social factors being taken into account.”⁶⁰

2809 **REMEDIATION PROCESS**

2810 Through the remediation process, government officials will work with stakeholders in the affected
2811 community to determine which areas require remediation, the extent of that remediation, the
2812 methods to conduct necessary remediation, and a process to confirm that remediation goals were
2813 achieved.

2814 Planners should be aware that many steps in the remediation process will be iterative and ongoing
2815 across protective action phases. Remediation zones, cleanup levels, decontamination techniques,
2816 and even public acceptance of the chosen course of action may evolve over time. These steps
2817 should be clearly articulated in radiological response and recovery plans, so that expectations are
2818 set for contractors, the government, and impacted stakeholders. The remediation process can be
2819 divided into five major steps (see Figure 8):

2820 1. **Optimize Target Cleanup Level(s):** The outcome of optimization is to determine a target
2821 cleanup level(s)⁶¹ that is acceptable to government officials (including regulatory authorities)
2822 and stakeholders (the public) within the affected community. For scenarios where a large site
2823 or area has been contaminated, planners will need to identify “remediation zones” to allow
2824 for phased remediation, promotion of remediation worker safety, and efficient allocation of

⁶⁰ ICRP (2006). “ICRP Publication 101b: The Optimisation of Radiological Protection: Broadening the Process.”. Available online at: <https://www.icrp.org/publication.asp?id=ICRP%20Publication%20101b>

⁶¹ Sometimes referred to as “release criterion,” “release limit,” “cleanup standard,” “clearance levels,” or “cleanup goals.”

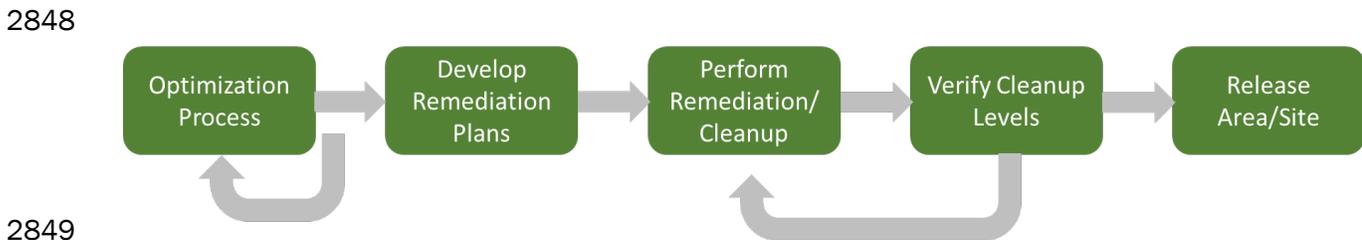
2825 resources.⁶² In most scenarios, optimization will entail extensive modeling, establishment of
2826 priorities and remediation goals, and planning for the speed, extent, and sequencing of
2827 remediation activities.

2828 1. **Develop Remediation Plans:** During this step, radiation expertise from Federal, STTL, and
2829 private sector will develop plans which outline how remediation activities will be conducted
2830 and how the achievement of stated remediation goals, including clearance levels, will be
2831 verified. It is likely that contractor support will be required for remediation in almost all
2832 potential RDD scenarios.

2833 2. **Perform Remediation/Cleanup:** Remediation will be performed by Federal and STTL
2834 personnel with contract support (altogether Remediation personnel). These personnel will
2835 perform the range of activities to including remediation, remediation management,
2836 radiological monitoring, health and safety, and contract oversight. Additional background
2837 information on the terminology, techniques, and technologies used to perform remediation is
2838 included in Annex D.

2839 3. **Verify Cleanup Levels:** Government authorities and contract technical support personnel
2840 independent of the remediation contractor will verify that cleanup levels have been achieved
2841 in accordance with the remediation plan. If they are not, additional remediation is conducted
2842 (possibly incorporating different techniques or a return to the optimization process).
2843 Alternatively, if additional remediation is not feasible or effective, access to the area/site
2844 may remain restricted.

2845 4. **Release the Area/Site:** If desired cleanup levels are achieved, the area is released for public
2846 use, potentially with changes or restrictions to land-use. If cleanup levels are not achieved,
2847 access may be restricted. Focus Area 9 discusses the release process in further detail.



2849
2850 **Figure 8: Remediation Process Flow Chart**

⁶² For more discussion, see NRC (2014) *Report 175: Decision Making for Late-Phase Recovery from Major Nuclear or Radiological Incidents*.

2851



Recommended Resources: Annex B

2852

Refer to Annex B: Remediation Decontamination and Demolition Techniques and Technologies for an overview of the key concepts, methods, and techniques for remediation of environments contaminated with radiological materials due to an incident such as an RDD detonation.

2853

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Table 15: Summary of Focus Area 7 Activities

	Activity	Phase
7.1	Execute the Optimization Process for Defining Remediation Zones and Clean-up Levels	Intermediate to Late (Weeks to Months)
7.2	Develop Remediation Plans	Intermediate to Late (Weeks to Months)
7.3	Perform Remediation/Clean-up	Late (Months to Years)
7.4	Verify Clean-up Level Compliance	Late (Months to Years)
7.5	Release Area/Site (Discussed in detail in Focus Area 9)	Late (Months to Years)

2856



Recommended Resources: Codes for Calculating Dose and Cleanup Levels

2857

There are numerous software codes used by radiation remediation experts that assist in calculating clean-up levels based on the radiological dose and risk to humans and the environment before remediation and through the alternative actions for remediation. These codes are commonly used in the nuclear industry and are readily available for emergency response.

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Activity 7.1: Execute the Optimization Process for Defining Cleanup Levels and Remediation Zones

2864

- **Identify Cleanup Level(s):** The government, aided by public health experts, radiation technical working groups (R-TWGs), conducts a cost-benefit analysis. This cost-benefit analysis should weigh the public health objective of reducing contamination and exposure to safe levels with the

2865

2866

2867 feasibility of the remediation effort required to meet those objectives.⁶³ The public health
2868 objective will leverage assessments of exposure pathways and dose conducted during activities
2869 described in Focus Area 2. The feasibility of the effort will vary based on the following factors:

- 2870 ○ Technical feasibility of the proposed decontamination and other remediation
2871 methods to achieve the target cleanup levels. For example, some contaminated
2872 surfaces may need to be fully removed or destroyed, instead of rinsed or scrubbed, to
2873 achieve the cleanup level(s) selected. Alternative methods of reducing exposure risk
2874 also may be identified as more appropriate (e.g., establishing barriers and signage).
2875 See Annex D for an overview of the techniques and technologies used to conduct
2876 radiological remediation.
- 2877 ○ Economic feasibility of the proposed cleanup levels, which includes the equipment,
2878 labor, and supporting infrastructure required to conduct the cleanup.
- 2879 ○ Land-use implications for cleanup level(s) chosen. For example, a public park and an
2880 elementary school in a residential neighborhood will have different implications in
2881 terms of both public acceptance and exposure pathways and risk.
- 2882 ○ Time requirements for cleanup and reoccupation.
- 2883 ○ Quantity of waste generated and the cost of waste storage, transportation, and
2884 disposal. Generally, as the cleanup level is lowered (e.g., the level of acceptable
2885 residual radiation decreases), the volume of waste generated will increase.
- 2886 ○ Social and economic considerations such as access to culturally significant sites,
2887 socioeconomic variables, and equity considerations.

2888  **Key Terminology: Remediation Zones**

2889 For releases that contaminate a large geographic area, it may be beneficial to establish
2890 Remediation Zones. These zones are specific areas within the contaminated area that will
2891 require decontamination and exposure reduction activities, usually with the intent of reopening
2892 them for future use. Initially, remediation zones should be areas that are determined to have
2893 similar (1) land-use and (2) levels of contamination. Designating areas into zones with similar
2894 characteristics can break the problem down into more manageable pieces, facilitate the

⁶³ Remediation planners translate the consensus cleanup level(s) into a value known as the “Derived Concentration Guideline Level” (DCGL). The DCGL represents the maximum allowable amount of residual contamination (for a given radionuclide) that results in a risk equal to the cleanup level determined. In other words, the DCGL establishes a ceiling on how much residual radioactivity is allowable after the cleanup is complete. More information can be found at: EPA (2023) *What is a Derived Concentration Guideline Level (DCGL)?* Available online at: <https://www.epa.gov/radiation/what-derived-concentration-guideline-level-dcgl>

2895 prioritization of areas for remediation, and potentially ease the logistical and planning burden
 2896 to conduct the clean-up itself.

2897 ■ **Designate Remediation Zones, if needed:** Identify areas in the **contaminated area** that have a
 2898 similar land-use and level of contamination. Land use can correspond to an exposure risk based
 2899 on the amount of time people spend in an area, as well as the activities they engage in (See
 2900 Table 16). Using these criteria, divide these areas into **remediation zones**.

2901 ○ Assess land-use and exposure risk by categorizing buildings/areas by type as shown
 2902 in Table 16.

2903 ○ Assess levels of contamination, leveraging data from Focus Areas 1 and 2, which
 2904 describe the extent and type of radiological contamination present. This assessment
 2905 should incorporate data that describes the actual levels of contamination as well as
 2906 the assessment of external and internal exposure pathways and dose.

2907 **Table 16: Example Land Use Types and their Exposure Implications**

Land Use Type	Exposure Frequency	Exposure Duration	Considerations
Residential	24 hours/day 365 days/year	30 years	Highest exposure frequency and duration produces the highest dose for a given level of contamination and may require the most stringent remediation goals. This could increase the per-square-footage cost for remediation and waste disposal. Highest in cost.
Industrial, Commercial, Business^a	8 hours/day 250 days/year	25 years	Workers may be allowed higher dose than public because of lower occupancy factor and personnel monitoring or dosimetry is possible. Remediation goals generally higher in radioactivity than residential, decreasing cost. However, this is dependent on workers and the public accepting a higher exposure.
Recreational^b	168 hours/year	30 years	Situation dependent. May include use as a waste disposal site for buried radioactive waste.
Road, mass transit, wastewater treatment sites, and other infrastructure	Infrequent, but also, highly variable	30 years	While exposure frequency may be infrequent for most people, separate consideration is needed for workers (e.g., wastewater treatment plant workers, sanitation workers, subway and commuter train workers, taxi drivers, etc.) as well as exposure to members of the public who live, work, or routinely transit on or adjacent to contaminated infrastructure.

Land Use Type	Exposure Frequency	Exposure Duration	Considerations
Sources:			
“Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.” OSWER Directive 9200.4-18. (EPA. August 22, 1997.) https://semspub.epa.gov/work/06/640873.pdf			
“Hanford Site Risk Assessment Methodology.” DOE/RL-91-45, Rev. 3. (May 1995.) https://www.nrc.gov/docs/ML0534/ML053400188.pdf .			
The examples cited here from CERCLA and legacy cleanup programs may not be directly applicable for an RDD scenario.			

- 2908 ▪ **Engage with Key Stakeholders:** Identify key stakeholders. There are five general categories of
- 2909 stakeholders: government, the public, property owners/managers, special interest groups, and
- 2910 businesses, as defined in Table 17.

- 2911 ○ Communicate the expected remediation timeline, responsibilities, and cleanup levels
- 2912 for the respective remediation zones. Early communication with stakeholders such as
- 2913 owners and tenants will benefit the long-term cost and timeliness of cleanup.

2914 **Table 17: Key Stakeholders in the Optimization Process**

Stakeholder	Description
Government	There are two primary types of government stakeholders: <ul style="list-style-type: none"> ▪ Government regulators and agencies who have a role in directing, executing, or facilitating the clean-up process. ▪ Government agencies whose operations or facilities are impacted by the incident.
Public/Community	Members of the public include residents, community organizations, neighborhood associations, and more, including individuals who are directly or indirectly impacted by the closure of contaminated areas. The community may also provide valuable input on prioritization of cleanup activities and other key decision factors.
Property Owners/Property Managers	An individual or company that owns or is hired to oversee the day-to-day operations of a unit of real estate and are directly or indirectly impacted by the closure of contaminated areas. These individuals retain legal decision rights regarding their properties, even though they may not physically reside in the contamination zone. (See Focus Area 7 for more information)
Businesses	Businesses are directly or indirectly impacted by the closure of areas. Recovery of businesses is also critical to enable reoccupation (discussed further in Focus Areas 9 & 10).

Stakeholder	Description
Special Interest Groups	Special interest groups, such as worker unions, environmental protection organizations, homeowners' association, business and trade groups, Parent-Teacher Associations, public health associations, and many others will be critically important trusted sources for communicating the health risks (or lack thereof) associated with the chosen clean-up levels and remediation zones. These groups may also provide valuable input on cleanup level decision criteria and/or prioritization of cleanup activities.

- 2915 ▪ **Revise Cleanup Levels, Technical Methods, and Remediation Zones:** Revisit the Optimization
- 2916 Process if needed (e.g., revisions to cleanup levels, technical methods, and remediation zones)
- 2917 once remediation begins based on changes to the estimated or actual technical, economic, and
- 2918 social feasibility of the proposed work. Additionally, other factors may warrant a return to the
- 2919 optimization process, such as changes to the risk and policy environments, lessons learned
- 2920 during early phase remediation, and availability of new technologies.

- 2921 ○ When technical, economic, and social feasibility of remediation are the reasons for
- 2922 revisiting the Optimization Process, the following are potential factors to adjust:

- 2923 – Increase or decrease cleanup levels: Changing cleanup levels can have a
- 2924 substantial impact on the entire remediation process. It can affect the feasibility
- 2925 of technical decontamination methods; the time required to perform remediation,
- 2926 the volume of waste produced, and possibly the classification of that waste. The
- 2927 cleanup standards chosen will likely be the most important factor determining
- 2928 the total cost of the remediation.

- 2929 – Adjust technical methods of remediation: As remediation continues, remediators
- 2930 may discover improved techniques for the particular area they are cleaning,
- 2931 allowing for changes to expectations for time and/or cleanup level.

- 2932 – Reduce, expand, or further divide remediation zone boundaries: Adjust
- 2933 remediation zones to align with desired cleanup levels. Shrinking and dividing
- 2934 remediation zone boundaries could allow for remediation operations to be
- 2935 organized in more manageable sizes, allowing for smaller, but prioritized areas to
- 2936 be reoccupied sooner.

- 2937 – Adjust land use to meet the feasible cleanup level: If the chosen cleanup
- 2938 strategies are too costly or require too much time, then either the target cleanup
- 2939 level and/or land-use may need to change.

2940 **Activity 7.2: Develop Remediation Plans**

- 2941 ▪ **Coordinate the Development of Remediation Plans:** Remediation partners (including Federal and
- 2942 STTL, as applicable) should prepare a remediation plan for the remediation zone(s) within their
- 2943 jurisdictions.
 - 2944 ○ The remediation plan will specify the cleanup levels, DCGLs, and specific
 - 2945 decontamination techniques that will be used to achieve them. It should reference
 - 2946 other plans that detail how work will be conducted safely by remediation workers and
 - 2947 how confirmation of the cleanup levels will be achieved.
 - 2948 ○ Plan components are summarized in Table 18. It is possible that more than one
 - 2949 remediation plan will be needed within a given remediation zone to cover specific
 - 2950 buildings (e.g., such as “interior” vs. “exterior” cleanup operations).
- 2951 ▪ **Review and Approve Remediation Plans:** Identify and obtain necessary approvals.
 - 2952 ○ As appropriate for the affected jurisdiction(s) and depending on the number and
 - 2953 complexity of remediation plans that require oversight, government reviewers, such
 - 2954 as an R-TWG, incident commander, safety officer, emergency management agency,
 - 2955 local/state health department, local/state environmental protection agencies,
 - 2956 and/or other regulatory agencies should review and approve remediation plans.
 - 2957 ○ Jurisdictions may need to provide additional qualified contractor support to help with
 - 2958 the technical workload to avoid the review process becoming a limiting factor in
 - 2959 restoring more timely access to contaminated areas.

2960 **Table 18: Components of a Remediation Plan**

Plan Component	Description
Data Quality Objectives (DQOs)	Process for defining objectives that ensure collection of the type, quantity, and quality of data needed to reach defensible decisions and credible estimates to support the remediation process.
Final Assessment/Survey Plan	Provides procedures and requirements used by regulatory agencies overseeing the remediation process. Purpose is to determine if desired clean-up levels have been achieved and identify what to do if they have not (e.g., continued remediation, adjust clean-up levels, and/or adjust land-use and institute long-term restrictions on human activity).

Plan Component	Description
Health & Safety Plan (HASP)	Required by the HAZWOPER regulations ⁶⁴ and prepared and followed by any employer whose workers engage in hazardous waste operations. Addresses safety and health hazards of each phase of site operations and includes requirements and procedures concerning employee protection. Example guidelines for a HASP can be found in the DOE limited standard (DOE-EM-STD-5503-94) ⁶⁵
Sampling and Analysis Plan (SAP)	Provides a process for obtaining data of sufficient quality and quantity to satisfy data needs. <ul style="list-style-type: none"> ▪ Field Sampling Plan: which describes the number, type, and location of samples and the type of analyses.⁶⁶ ▪ Quality Assurance Project Plan: which describes policy, organization, functional activities, DQOs, and measures necessary to achieve adequate data for use in selecting the appropriate remedy.
Technical Decontamination Work Plan	Describes the actual methods and schedule for conducting the decontamination work.
Waste Management Plan	Provides an overview of the volume of waste estimated to be generated from remediation activities and type/class of waste produced. This plan should outline the specific operational methods and techniques the contractor(s) will use to safely contain, store, transport, and dispose of the various waste streams that result from their remediation work procedures. Covers all waste streams, not just radiologically contaminated waste. Plans should also include waste minimization strategies, worker health and safety precautions, dosimetry monitoring, and any treatment plans for waste.

2961 **Activity 7.3: Perform Remediation/Cleanup**

- 2962 ▪ **Coordinate with regulatory agencies:** Oversight of remediation cleanup will involve Federal and
2963 STTL health and safety, environmental and radiological regulatory agencies. Remediation will
2964 also entail frequent communication with R-TWG and affected jurisdictions.
- 2965 ▪ **Implement remediation plans:** Implement the remediation plans identified in Activity 7.2
2966 (summarized in). Considerations for performing remediation activities include:

⁶⁴ OSHA (1910.120 – Hazardous waste operations and emergency response. Available online at: <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.120>

⁶⁵ DOE (1994) “EM Health and Safety Plan, DOE-EM-STD-5503-94. DOE Standard. Available online at: <https://www.standards.doe.gov/standards-documents/5000/5503-astd-1994/@@images/file>

⁶⁶ DOE (2000) *Decommissioning Handbook: Procedures and Practices for Decommissioning*. Available online at: <https://www.osti.gov/servlets/purl/1491121>.

- 2967 ○ Maintaining regulatory and legal compliance while performing remediation activities,
2968 especially those related to worker safety and health.
- 2969 ○ The amount of waste to be generated by specific remediation actions. Managing
2970 waste streams is critical at this stage and are described further in Focus Area 9.
- 2971 ○ Whether the remediation actions themselves may generate further radiological
2972 hazards to the population, such as through the generation of dust or water runoff
2973 that is contaminated.
- 2974 ■ **Provide wraparound services for remediation activities:** Provide security, project management,
2975 and ongoing public communication/outreach services to support remediation efforts as required.
- 2976 ■ **Mitigate factors which may limit the speed and efficiency of remediation activities.** Such factors
2977 may include:
 - 2978 ○ Personnel, equipment, and other resources to perform remediation may be limited
2979 until additional capacity can be identified, trained, and mobilized.
 - 2980 ○ Availability of waste storage and disposal facilities may be limited until additional
2981 storage locations are identified (See Focus Area 8 for more information).
 - 2982 ○ Access and right-of-entry to areas where remediation must be performed, such as
2983 obtaining necessary entry permits to conduct work on private property, could delay or
2984 complicate remediation work.
 - 2985 ○ Feasibility of remediation approaches in different scenarios and contexts, such as
2986 working in an urban environment, may complicate remediation activities.
 - 2987 ○ Public acceptance of remediation actions, methods, and processes may change over
2988 time, delaying and complicating remediation efforts.
- 2989 ■ Considerations for Engaging Remediation Contractor Support for Jurisdictions Pursuing
2990 Remediation on their Own Ensuring safety for those working in hazardous environments is a
2991 key priority.
- 2992 ■ Remediation activities like power-washing, grinding concrete and asphalt, and other
2993 activities may result in resuspension and/or movement of radioactive material.
- 2994 ■ Environmental considerations associated with different land use types (commercial,
2995 industrial, residential, agricultural, etc.) drive many remediation decisions.
- 2996 ■ Federal agencies like EPA, DOE, NRC, and others with expertise in radiological hazards may
2997 be able to provide guidance for working with private sector remediation contractors.
2998 Remediation contractors may require special licensing and operate under other special rules
2999 and restrictions related to the hazardous nature of the work to be performed. Jurisdictions

- 3000 should ensure that contractors are qualified and properly supervised to perform remediation
3001 work.
- 3002 ▪ Support of multiple contractors and subcontractors working in concert likely will be required.
- 3003 ▪ Contracted activities may represent a mix of government, contractor, and community-led
3004 activities. Some remediation work may be directed by the government (especially for public
3005 property), while other remediation work may be led by private sector entities and individual
3006 homeowners. It is likely that multiple aspects of remediation work will be ongoing
3007 concurrently.

3008 **Activity 7.4: Verify Cleanup Level Compliance**

- 3009 ▪ **Conduct Data Verification, Validation, and Quality Assessment:** Evaluate survey plans and data to
3010 determine compliance with Derived Concentration Guideline Levels (DCGLs). The process for
3011 verifying cleanup levels is defined in a Final Assessment/Survey Plan. This assessment involves
3012 the Data Life Cycle⁶⁷, consisting of:
- 3013 ○ Data verification: Ensures the requirements stated in the remediation plans are
3014 implemented as prescribed.
- 3015 ○ Data validation: Ensures the results of the data collection activities support the
3016 objectives of the survey as documented in the Quality Assurance Project Plan or to
3017 permit a determination that these objectives should be modified.
- 3018 ○ Data Quality Assessment (DQA): Represents the scientific and statistical evaluation of
3019 data to determine if the data are of the right type, quality, and quantity to support
3020 their intended use. DQA helps complete the Data Life Cycle by providing the
3021 assessment needed to determine that the planning objectives are achieved.
- 3022 ▪ **Conduct a Final Assessment Survey:** As part of the Final Assessment/Survey Plan, a survey is
3023 conducted that will take readings to compare the residual radiation amounts to those that were
3024 assessed before the remediation actions were performed.
- 3025 ○ If achieved radiation levels are in excess of those projected during the planning
3026 phase, additional remediation activities may need to be performed and/or the
3027 remediation plan may need to be revised, potentially including a return to the
3028 Optimization Process.
- 3029 ▪ **Conduct Verification:** Independent verification should be conducted by a third party that has no
3030 vested interest in the outcome of the Remediation Process, and is the last step to verify cleanup
3031 levels.

⁶⁷ Data Life Cycle is further described in *MARSSIM* and EPA's *Data Quality Assessment: A Reviewer's Guide*.

- 3032 ○ As with other steps of the process, verification is iterative and ongoing. Since
3033 radioactive material may move around in the environment, data collected during the
3034 verification phase is also useful as part of ongoing survey and dose assessment
3035 activities to further refine the collective picture of overall radioactive contamination.

- 3036 ○ Especially for events of large scale or occurring in a highly populated area, it is likely
3037 that verification will be an important topic for public messaging. Populations are likely
3038 to ask for assurances that comprehensive surveys have been performed and that
3039 radioactivity levels have been reduced to acceptable target levels.

- 3040 ○ Feedback from independent verification should be incorporated into the release
3041 report for Activity 7.5.



Recommended Resources: Radiological Data Assessment Guidance

- 3042
- 3043 ■ *Radiological Data Assessment Guidance*. The Data Quality Assessment Toolkit helps
3044 officials understand how much sampling and surveying is required, how trustworthy their
3045 collected data is, and when they have enough data to determine that it's safe.
3046 <https://www.cbrnresponder.net/app/index#resources/documents/download/2308>.
- 3047 ■ *RESRAD*. The RESidual RADiation (RESRAD) family of codes is used to evaluate radiation
3048 exposure and associated risks and to derive cleanup criteria or authorized limits for
3049 radionuclide concentrations in the contaminated source medium (e.g., water). The RESRAD
3050 family of codes is widely used by regulatory agencies and the risk assessment community.
3051 <https://resrad.evs.anl.gov/>.

3052 Activity 7.5: Release the Area/Site

- 3053 ■ **Publish Release Report:** Transmit release report and associated documentation to applicable
3054 federal, state, and municipal regulatory agencies.

- 3055 ○ The Release Report documents the recommended future use of the formerly
3056 contaminated area/site.

- 3057 ○ If the site/area cannot be released for unrestricted use, the documentation identifies
3058 any controls (administrative or engineered) that are to remain in place, and for how
3059 long. For example, additional monitoring may be required, and the area/site re-
3060 evaluated periodically.

- 3061 ○ Note: Focus Area 9 provides guidance on reopening areas and considerations related
3062 to limited use.

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3065
- **Obtain Necessary Approvals and Concurrences:** Upon acceptance of the verification documents, applicable federal and state agencies will provide documentation that the contaminated area has been remediated to agreed-upon cleanup levels for the area.
- 3066
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- **Maintain Vital Records:** Records management of all verification documents is a key consideration for this activity, as these records will provide the baseline for future evaluations of what work has been performed, which locations material has been moved to for storage, and other historical data.



Potential Remediation Resources:

- 3071
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- See also Annex D: Remediation Decontamination and Demolition Techniques and Technologies
- 3073
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3075
3076
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3078
- *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.* OSWER Directive 9200.4-18. (U.S. Environmental Protection Agency, Office of Emergency and Remedial Response and Office of Radiation and Indoor Air, 1997) <https://semspub.epa.gov/work/06/640873.pdf#:~:text=Slope%20factors%20were%20developed%20by%20EPA%20for%20more,standard%20Agency%20risk%20language%20consistent%20with%20CERCLA%20guidance.>
- 3079
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3081
3082
- *Protective Action Guides and Planning Guidance for Radiological Incidents.* PAG Manual: EPA-400/R-17/001. (U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Radiation Protection Division, 2017.) <https://www.epa.gov/radiation/protective-action-guides-pags>
- 3083
3084
3085
3086
- *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).* EPA 402-R-97-016, Revision 1. (U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Radiation Protection Division, August 2000)⁶⁸ https://www.epa.gov/sites/default/files/2017-09/documents/marssim_manual_rev1.pdf
- 3087
3088
3089
3090
- “Radiation at Superfund Sites,” www.epa.gov. (U. S. Environmental Protection Agency, 2021) <https://www.epa.gov/superfund/radiation-superfund-sites>. This page provides EPA remedial project managers with information and guidance on the cleanup of radioactive contamination at Superfund sites.
- 3091
3092
3093
3094
- *Radiation Site Cleanup Regulations: Technical Support Document for The Development of Radionuclide Cleanup Levels for Soil.* EPA 402-R-96-001a, Review Draft. (U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, 1994.) https://www.epa.gov/sites/default/files/2015-05/documents/402-r-96-011a_intro.pdf

⁶⁸ This manual is currently being revised. For information on the development of Revision 2 visit: <https://www.epa.gov/radiation/multi-agency-radiation-survey-and-site-investigation-manual-marssim-proposed-revision-2> .

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- 3101
- 3102
- 3103
- *Data Quality Assessment: A Reviewer’s Guide*. EPA QA/G-9R, EPA/240/B-06/002. (U.S. Environmental Protection Agency, Office of Environmental Information, 2006.) <https://www.epa.gov/sites/default/files/2015-08/documents/g9r-final.pdf>
 - *Removal Action* (Title 40 Volume 29 section 300-415 (40 CFR 300.415), US Code of Federal Regulations.) <https://www.gpo.gov/fdsys/granule/CFR-2012-title40-vol29/CFR-2012-title40-vol29-sec300-415>
 - *Decommissioning Handbook: Procedures and Practices for Decommissioning*. DOE/EM-0383. (U.S. Department of Energy, 2000) <https://www.osti.gov/servlets/purl/1491121>

3104 Focus Area 8: Manage and Dispose of Waste

3105 **Guidance:** Conduct early-phase waste management and containment operations, including
 3106 designating temporary waste storage sites and waste transportation procedures. Then, estimate the
 3107 volume of waste and types of waste streams that will be generated by remediation work. Finally,
 3108 develop a long-term disposal plan.



3109 Recommended Planning Partners:

- 3110 ▪ Environmental protection
- 3111 ▪ Transportation
- 3112 ▪ Radiation protection
- 3113 ▪ Public Health
- 3114 ▪ Waste management and remediation contractors

3115 Introduction

3116 An RDD detonation may involve a large area of radiological contamination including radioactive
 3117 debris in the blast zone and radiologically contaminated soils, exterior and interior surfaces of
 3118 buildings and other structures, paved surfaces, vegetation, automobiles, mass transit, etc. Cleanup
 3119 of these contaminated surfaces may generate large quantities of radiological wastes. As response,
 3120 recovery, and remediation activities are implemented, additional radiological waste may be produced
 3121 over the course of the incident. Most, if not all, radioactive waste likely will be categorized as some
 3122 form of low-level radioactive waste (LLRW) or potentially mixed waste (radioactive and hazardous
 3123 waste), which includes explosion debris and other contaminated materials that may need to be
 3124 relocated to allow the completion of critical response and recovery activities. Table 19 summarizes
 3125 the different types of waste that may be generated as the result of an RDD incident along with
 3126 potential disposal options. Disposing of some of this material may require coordination with law
 3127 enforcement officials due to its potential evidentiary value.

3128 Moving from the intermediate to late phase, remediation activities will generate considerable and
 3129 diverse waste streams for disposal. Handling, packaging, transporting, and disposing of radioactively
 3130 contaminated materials from an RDD incident are likely to account for a substantial portion of
 3131 recovery costs and will involve adherence to complex regulatory requirements. Failure to anticipate
 3132 such requirements will delay remediation and reoccupation of contaminated areas. Waste
 3133 management will remain an important activity throughout all phases of response and recovery.

3134 Properly addressing the various waste-related issues stemming from an RDD incident will require the
 3135 development and implementation of a comprehensive waste management and disposal plan. The
 3136 most effective approach to RDD-related waste management includes extensive pre-incident waste
 3137 management planning. EPA and DHS recommend that jurisdictions perform pre-incident waste

3138 planning for all hazardous, including nuclear radiological hazards. While most communities are
 3139 familiar with solid and non-radiological hazardous waste management, the development of an
 3140 appropriate plan to address the complexities associated with radiological waste and mixed waste will
 3141 require specialized expertise. Tailorable pre-incident waste management plans – which could take
 3142 the form of an annex to an existing all-hazards debris plan or a standalone plan that includes
 3143 provisions for radioactive and mixed waste – are critical to avoid unnecessary challenges later in the
 3144 response.

3145 The EPA has developed an online decision support tool to facilitate development of a pre-incident
 3146 waste management plan that could be tailored to the specifics of an actual incident.⁶⁹

3147 Remediation plans developed by remediation partners performing remediation work should be
 3148 based on the parameters identified in the overarching waste management plans developed by the
 3149 responding jurisdiction(s). Such plans should outline the specific operational methods and
 3150 techniques that will be used to safely contain, store, transport, and dispose of the various waste
 3151 streams that result from remediation work (see Table). Remediation partners should also consider
 3152 the clean-up levels and decontamination techniques selected through the Optimization Process, as
 3153 these decisions can have a substantial impact on the amount and type of waste generated.
 3154 Contractor remediation plans should be reviewed and approved by appropriate government
 3155 agencies.



Key Terminology: Types of Waste

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3157 **Radioactive waste** is any type of waste that contains radioactivity, either intrinsically or through
 3158 contamination with radioactive material. There are three classes of radioactive waste (A, B,
 3159 and C), based on the amount of radioactivity present. Class A **low-level radioactive waste**
 3160 (**LLRW**) is the most likely type of radioactive waste to result from an RDD. If radioactive waste
 3161 is combined with hazardous but non-radioactive waste, it is considered **mixed waste**.

3162 **Table 19: Overview of Waste Types**

Classification ⁷⁰	Examples of Waste Types	Potential Disposal or Storage Location(s)
Non-radiological solid waste	<ul style="list-style-type: none"> Uncontaminated components of buildings and structures, vegetation, discarded items 	Municipal or industrial landfills

⁶⁹ The EPA’s online decision support tool is available at <https://wasteplan.epa.gov/>

⁷⁰ Waste classifications identified as part of EPA (2012) “Wide Area Recovery and Resiliency Program Waste Management Workshop.”: Available online at: www.epa.gov/sites/production/files/2015-08/documents/warrp_workshop_report_0.pdf

Classification ⁷⁰	Examples of Waste Types	Potential Disposal or Storage Location(s)
Non-radiological hazardous waste	<ul style="list-style-type: none"> ▪ Building supplies containing asbestos or Polychlorinated biphenyls (PCBs)⁷¹ ▪ Specialized waste, e.g., medical waste or biological waste 	Hazardous waste landfills
Class A low-level radioactive waste (LLRW)	<ul style="list-style-type: none"> ▪ Rubble, soil, and other contaminated surfaces with lower radioactivity levels ▪ Likely most of the waste from the contaminated area 	Temporary storage or permanent radioactive waste storage site
Class B/C radioactive waste	<ul style="list-style-type: none"> ▪ Materials with higher radioactivity levels from the blast zone ▪ Likely a small fraction of total waste by volume and weight 	Temporary storage or permanent radioactive waste storage site
Low-level mixed waste (hazardous waste and low-level radioactive waste)	<ul style="list-style-type: none"> ▪ Low-level radioactive waste with asbestos (i.e., old steam pipes from demolished buildings) ▪ Low-level radioactive waste with PCBs (i.e., PCB transformer oils coating demolished building exteriors) ▪ Waste from water treatment or wastewater treatment (including sludges) that are determined to be radioactive ▪ Specialized waste (e.g., human or animal remains) that is determined to be radioactive ▪ Some mixed waste can be treated to remove the hazardous component, allowing it to be reclassified as LLRW. 	Temporary storage or permanent radioactive waste storage site
Aqueous waste	<ul style="list-style-type: none"> ▪ Stormwater runoff from the contaminated area ▪ Wastewater generated from decontamination activities 	Discharge into large bodies of water, temporary storage, or permanent radioactive waste storage site

⁷¹ PCBs are carcinogenic chemical compounds that were used in industrial and consumer products prior to being banned in 1979. (<https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs>)

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Recommended Resources: EPA’s Waste Management Guidance

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- EPA’s “Pre-incident All-hazards Waste Management Plan Guidelines: Four-step Waste Management Planning Process” available at:

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https://www.epa.gov/sites/default/files/2019-05/documents/4_steps_document.pdf

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- EPA also provides an All-Hazards Waste Management Planning (WMP) Tool, available online at <https://wasteplan.epa.gov/>

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Table 20: Summary of Focus Area 8 Activities

	Activity	Phase
8.1	Conduct Early-Phase Waste Management and Containment Operations	Early to Intermediate (Days to Weeks)
8.2	Estimate the Volume of Waste and Establish Waste Management Goals	Intermediate to Late (Weeks to Months)
8.3	Identify Long-Term Waste Disposal Options and Inter-Jurisdictional Transportation Requirements	Late (Months to Years)

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Activity 8.1: Conduct Early-Phase Waste Management and Containment Operations

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- Identify temporary waste/debris staging and storage locations both within and outside of the contaminated area (e.g., on-site and off-site locations away from the contaminated area that are pre-designated for waste disposal activities). This identification should be done as early as possible following recognition of an RDD incident. Considerations for selecting a temporary storage area are provided in the box below; these considerations should be included in pre-incident waste management planning whenever possible. Note, however, that pre-selection of specific storage or staging sites, rather than just criteria, will likely be highly controversial and of potentially limited utility as the location of the RDD would be unknown. Additionally, the EPA has developed a GIS-based Waste Storage & Staging Tool that uses suitability analysis to aid in the selection of temporary storage and staging areas⁷².

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- Existing radioactive waste disposal sites may be insufficient for a major RDD incident. Accordingly, planners must identify suitable sites where radioactive and mixed waste

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⁷² EPA’s Waste Storage & Staging Tool is a GIS-based decision support tool for identifying and prioritizing potential waste staging and storage sites and works in coordination with EPA’s WEST. The tool can be downloaded from: https://github.com/USEPA/Waste_Staging_Tool

3184 can be temporarily stored while waiting for additional permanent storage capacity to
3185 become available⁷³.

3186 ○ Temporary storage may also be necessary if decisions about final waste deposition
3187 are delayed. If the radioactive material has a short half-life, storage within the
3188 contaminated area may allow material to become significantly less radioactive while
3189 other remediation activities occur.

3190 **Criteria for a Temporary Storage Area**

- 3191 ▪ Located away from heavily populated areas
- 3192 ▪ Convenient access to transportation routes for ingress/egress
- 3193 ▪ Features that reduce or prevent the spread of contamination from the waste into the
3194 environment (e.g., shelter from wind and rain; pest mitigation; impermeable floors)
- 3195 ▪ Minimal non-radiological hazards
- 3196 ▪ Accommodates box trucks/tractor trailers (e.g., loading docks; enough space for turning
3197 radius). Although not required, access to rail/train transportation at staging sites may help to
3198 reduce logistical burdens.
- 3199 ▪ Running water for dust control
- 3200 ▪ Electricity for lighting and air monitoring
- 3201 ▪ Security and controlled access
- 3202 ▪ Includes or is adjacent to work areas where waste can be surveyed for radioactivity, sorted,
3203 cut into smaller pieces, loaded into packages, etc.

3204 ▪ Use administrative and engineering controls (defined in Focus Area 2) to limit the spread of
3205 contamination generated by emergency response activities. Some controls, such as following
3206 radiological-HAZMAT procedures for bagging and containing contaminated PPE, require minimal
3207 resources and can be implemented very early in the response. Others, such as using physical
3208 barriers to contain or redirect contaminated runoff, will require more resources, and should be
3209 implemented as resources become available. Implementation of controls should be delayed if
3210 they divert resources from lifesaving and high-priority health protection activities. Appropriately
3211 package and transport waste generated from emergency response activities to the identified
3212 temporary storage location(s). At a minimum, expect waste streams from the following locations:

⁷³ EPA has developed numerous tools to address managing waste after an incident like an RDD. Access to the toolkit is available at: <https://www.epa.gov/emergency-response-research/decision-support-tools-waste-management>

- 3213 ○ CRCs, shelters, contaminated area access points, and other sites where
3214 decontamination is performed: Contaminated personal effects that could not be
3215 decontaminated, responder PPE, and wastewater run-off.
- 3216 ○ Residences and businesses: Clothing bagged by members of the public who are
3217 following self-decontamination instructions.
- 3218 ○ Hospitals and other medical facilities: Contaminated personal effects that could not
3219 be decontaminated, responder/healthcare provider PPE, wastewater run-off,
3220 responder vehicles, and medical equipment.
- 3221 ■ Instruct each location where waste is generated on how to safely store radioactive waste until it
3222 can be picked up. To the extent possible, waste should be placed in sealed, waterproof
3223 containers (such as plastic bins or sealed plastic bags), positioned away from people and pets,
3224 and protected from weather.



Recommended Resources: Waste Management Tools

- 3226 ■ RDD Waste Estimation Support Tool (WEST) available at: [https://www.epa.gov/emergency-](https://www.epa.gov/emergency-response-research/waste-estimation-support-tool-west)
3227 [response-research/waste-estimation-support-tool-west](https://www.epa.gov/emergency-response-research/waste-estimation-support-tool-west)
- 3228 ■ Waste Storage & Staging Tool available at: https://github.com/USEPA/Waste_Staging_Tool
- 3229 ■ I-WASTE DST available at: <https://iwaste.epa.gov/guidance>

Activity 8.2: Estimate the Volume of Waste and Establish Waste Management Goals

- 3232 ■ Establish goals and expectations for waste management in the intermediate or late phase
3233 through coordination with remediation contractors, radiological technical working groups (R-
3234 TWGs) and regulatory government agencies⁷⁴. This includes:
 - 3235 ○ Establish waste acceptance criteria and waste segregation strategies by waste type
3236 (e.g., radioactive waste, mixed waste, hazardous waste) and waste characteristics
3237 (e.g., aqueous waste, combustible waste, compactible materials like PPE, non-
3238 compactible debris from buildings, or vegetation).
 - 3239 ○ Develop strategies for mixed waste that could be treated to remove non-radiological
3240 contaminants.

⁷⁴ FEMA's recommendations for authorities involved in waste management decisions available online at: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf

- 3241 ○ Define potential residual radioactivity levels that would make waste eligible for
3242 municipal disposal options (e.g., existing landfills for the area).
- 3243 ○ Define criteria for items that may be reused in contaminated areas (e.g., vehicles or
3244 trash bins) with minimal or no decontamination versus requiring final disposal.
- 3245 ■ Weigh the costs and benefits of treatment against the costs of disposal or storage. It may be
3246 more cost effective to dispose of and replace some items rather than attempt decontamination
3247 (e.g., contaminated personal clothing collected at a CRC).
- 3248 ■ Estimate the quantity and characteristics of the waste. EPA’s Waste Estimation Support Tool
3249 (WEST) can be used for this process.
- 3250 ■ While establishing goals and expectations for waste management, coordinate with remediation
3251 partners and government officials who are managing the optimization process.
- 3252 ○ The specific remediation techniques (e.g., washing, using strippable coatings,
3253 demolishing) selected by remediation partners and approved by the responding
3254 governmental authorities through the optimization process will have a significant
3255 influence on the volume and type of waste generated.
- 3256 ○ As discussed above and in Focus Area 8, remediation partners will develop a
3257 separate waste management plan that details how they manage radiological waste
3258 while conducting remediation.

3259 **Activity 8.3: Identify Long-Term Waste Disposal Options and Inter-** 3260 **Jurisdictional Transportation Requirements**

- 3261 ■ Identify options for the disposal of radioactive waste in coordination with local, state, and federal
3262 regulatory agencies, including the EPA and NRC. There are three primary options for disposal of
3263 radioactive waste; radiation technical experts will be able to determine which disposal options
3264 are best suited to the materials involved.
- 3265 ○ **Decay in storage.** Waste containing only short-lived radionuclides (generally those
3266 with a half-life of 90 days or less) can be temporarily stored in a dedicated facility or
3267 left in-place for ten half-lives and until the radioactivity has decayed to levels that are
3268 indistinguishable from background radiation. At that point, such waste is no longer
3269 considered to be “radioactive material” and may be released for disposal without
3270 regard to radioactivity. This waste may need to be disposed of based on other
3271 characteristics, such as hazardous waste. This approach is only feasible for a limited
3272 number of radionuclides which have a relatively short half-life (e.g., Iodine-131), but
3273 can be cost-effective and reduce concerns associated with transporting radioactive
3274 materials.

- 3275 ○ **Transfer to a licensed disposal site.** Long-term disposal in a licensed radioactive
3276 waste disposal facility moves contaminated waste to locations where people and the
3277 environment will not be put at risk. An LLRW disposal facility is licensed by either the
3278 Nuclear Regulatory Commission (NRC) or an Agreement State (states that have
3279 signed an agreement with the NRC authorizing the state to regulate certain uses of
3280 radioactive materials within the state). Low activity waste could also be disposed of in
3281 a RCRA C or D facility with low level radiological waste disposal authority. State
3282 authorities can grant approval for this type of disposal.
- 3283 ○ **Discharge into the sanitary sewer system or into surface waters (e.g., river, ocean).**
3284 Depending on governing FSLTT regulations, aqueous waste may be discharged into
3285 the sanitary sewer system or large bodies of water (e.g., river, ocean, etc.). This
3286 approach is only an option if the radionuclide concentration in the effluent (in the
3287 case of discharges to the sanitary sewer system) or in the body of water remains
3288 below regulatory limits, which vary by state. This release of effluents below regulatory
3289 limits is a disposal methodology used by nuclear power plants and other radioactive
3290 materials licensees throughout the U.S. and in other nations.⁷⁵ While nuclear plants
3291 and other industrial releases of radionuclides (such as from nuclear medicine
3292 suppliers) are routine, considerable effort is often required to ensure compliance with
3293 applicable regulations (and obtain appropriate permits) so it may be difficult to plan
3294 for given the unknown nature of a radiological incident. If precipitation occurs during
3295 or shortly after a release, discharge into surface waters may happen naturally, as
3296 contaminated material is washed into water systems. In that case, affected sewer or
3297 surface water systems should be assessed for contamination, as described in Focus
3298 Area 1.
- 3299 – Additionally, there are commercial water treatment systems capable of treating
3300 radiologically contaminated water. If this treatment is a desired and feasible
3301 waste solution, remediation partners should request discharge criteria from state
3302 and federal regulators and procure and develop treatment capacity for this
3303 wastewater.
- 3304 ■ Engage with the public to discuss waste management disposal options to support decision
3305 making for cost-effective and safe waste staging and disposal.
- 3306 ○ Engagement discerns priorities for public acceptance of cost-effective
3307 recommendations for waste staging and disposal.
- 3308 ■ Select long-term waste disposal sites on site and/or off-site:

⁷⁵ NRC (2022) *Radioactive Effluent and Environmental Reports*. Available online at:
<https://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html>

- 3309 ○ Long-term storage on-site (i.e., within/near the contaminated area) may be a good
3310 option if there are portions of the contaminated area that will not be remediated and
3311 are otherwise suitable for storage, or if the radioactive waste contains short-lived
3312 radionuclides that will decay in storage.

- 3313 ○ Waste may be transported to a disposition site outside the contaminated area. For a
3314 very limited radiological incident with a small waste volume, the four existing LLRW
3315 disposal facilities in the U.S. may be sufficient: Barnwell, South Carolina; Richland,
3316 Washington; Clive, Utah; and Andrew, Texas. However, in a situation involving a more
3317 significant release, supplements to existing commercial licensed radioactive waste
3318 disposal facilities may be required such as a combination of hazardous waste
3319 landfills, some solid waste landfills, DOE facilities, and construction of one or more
3320 new disposal facilities.

- 3321 – Off-site locations in another jurisdiction will require analysis of transportation
3322 routes and adherence to state and local regulations and ordinances governing the
3323 transportation of radioactive waste. If the site is far from the impacted
3324 jurisdiction, such as might be the case if the existing LLRW disposal facilities are
3325 used, then both the transport costs and level of effort to navigate regulations and
3326 ordinances for every state the waste transits through may be substantial.

- 3327 ■ Implement protocols and procedures with regional partners for coordinating inter-jurisdictional
3328 transportation of LLRW, if the permanent off-site storage locations are outside of your
3329 jurisdiction.

- 3330 ○ Identify FSLTT stakeholders who have regulatory jurisdiction impacting the
3331 transportation of LLRW and designation of long-term storage sites, and/or can assist
3332 in coordinating transportation activities. These may include:
 - 3333 – Local and state transportation agencies for transportation of hazardous, oversize,
3334 and overweight loads.
 - 3335 – US Department of Transportation (DOT) for transportation of hazardous waste.
 - 3336 – Law enforcement and/or fire departments for escort support.
 - 3337 – EPA and NRC for storage-site designation and characteristics.

- 3338 ■ Initiate the permit process for waste disposal and disposition.
 - 3339 ○ Permits for final disposition, whether on-site or off-site, are required to meet FSLTT
3340 regulations.
 - 3341 ○ Experienced remediation partners coordinate with regulatory FSLTT stakeholders.

3342



Recommended Resources:

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- EPA’s booklet titled Radioactive Waste Disposal: An Environmental Perspective describes the different categories of waste, discusses disposal practices for each type and describes the way they are regulated: <https://www.epa.gov/radiation/radioactive-waste-disposal-environmental-perspective>

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- FEMA’s recommendations for authorities involved in waste management decisions available at: https://www.fema.gov/sites/default/files/2020-07/fema_incident-annex_nuclear-radiological.pdf

3350

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- NRC’s Radioactive Waste Safety Research Program available at: <https://www.nrc.gov/waste.html>

3352

Strategy 5: Reopen and Recover

3353

Focus Area 9: Reopen

3354

Guidance: Determine the reopening criteria for buildings in the remediation zones, conduct final

3355

repairs/additional remediation, prepare the area for public, commercial, and residential access, and

3356

support a phased reopening of remediated areas.

3357



Recommended Planning Partners:

3358

- Emergency management

3359

- Environmental protection

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- Building and code officials

3361

- Human services

3362

- Public health

3363

- Occupational health and safety

3364

- Law enforcement

3365

- Recovery Support Functions

3366

- Public works

3367

- Urban planning and zoning

3368

Introduction

3369

“Reopening” refers to allowing residential re-habitation and/or industrial/business activities to safely

3370

resume in an area that was previously restricted from public access due to radioactive

3371

contamination or other impacts (such as blast damage) from the incident. Reopening can take place

3372

when law enforcement completes processing the designated crime scene for evidence and releases

3373

it to the proper authorities.

3374

Once reopening criteria are established, buildings in remediation zones are cleared through the

3375

radiological remediation process and must be inspected to ensure all clearance and physical safety

3376

and structural integrity requirements are met. This inspection and clearance may necessitate both

3377

cosmetic and functional repairs as well as additional final remediation measures.

3378

Jurisdictions should consider implications for pre-event planning, zoning, and code enforcement

3379

requirements, as these may need to be waived or modified in some way to reopen the affected

3380

areas.

3381 **Table 21: Summary of Focus Area 9 Activities**

	Activity	Phase
9.1	Establish Reopening Criteria for Structures in Remediation Zones	Intermediate to Late (Weeks to Months)
9.2	Conduct Repairs/Final Remediation and Prepare for Reopening	Intermediate to Late (Weeks to Months)

3382 **Activity 9.1: Establish Reopening Criteria for Structures in Remediation Zones**

- 3383 ▪ **Set parameters for reopening:** Establish requirements for reoccupation and reopening of
3384 residential-, industrial-, and commercial-use structures in remediation zones once they have
3385 achieved previously determined clearance goals, and law enforcement officials have released
3386 the areas previously designated as the crime scene. At a minimum, these requirements should
3387 incorporate:
 - 3388 ○ **Physical condition of structures and surrounding area:** Data collected through area
3389 sustainment activities described in Focus Area 6 should show that structural and
3390 aesthetic conditions of areas in the remediation zone are consistent with relevant
3391 codes and standards as well as local community expectations. Structures that are
3392 not compliant will not be able to be re-occupied.
 - 3393 ○ **Acceptable levels of residual contamination to determine reentry and/or relocation of
3394 impacted individuals, households, and businesses:** The optimization process
3395 (described in Focus Area 7) will establish target levels of residual radiation for the
3396 contaminated areas. If the levels of residual radiation are above those permissible
3397 for unrestricted public use, then restrictions to land use will need to be identified and
3398 enforced. Any restrictions to access or land use should be driven by health and safety
3399 analyses of variables such as how the property will be utilized, whether people will be
3400 there continuously or only for limited periods (in order to project likely total absorbed
3401 doses), etc. Table describes example criteria for land use adjustments that can be
3402 applied to areas based upon the residual levels of contamination following
3403 remediation activities. For example, two buildings may have similar residual radiation
3404 levels, but could be subject to different use restrictions based on the projected total
3405 amount of time people are reasonably expected to be inside the buildings in any
3406 given year.
 - 3407 ○ **Habitability:** FEMA broadly defines “uninhabitable” as a dwelling that is not safe,
3408 sanitary, or fit to occupy. “Safe” refers to being secure from disaster-caused hazards
3409 or threats to occupants and “sanitary” refers to being free of disaster-caused health

3410 hazards.⁷⁶ Different jurisdictions have varied or more specific requirements, such as
3411 availability of water/wastewater treatment/disposal, heat, electricity, and other
3412 essential services. If an area has been evacuated for an extended period or has been
3413 included in a relocation effort, some structures may have suffered environmental
3414 damage due to deferred maintenance. Those structures would need to be repaired
3415 and rehabilitated prior to being reoccupied.

3416 ○ **Availability/restoration of Community Lifelines:** FEMA has identified seven
3417 “Community Lifelines” which jurisdictions can use to better understand the impact of
3418 an emergency on the population and prioritize recovery activities. These same lifeline
3419 categories can also be used to evaluate the availability of critical utilities and
3420 services on which a typical community, neighborhood, and household relies. Since
3421 reoccupation is ultimately a voluntary process for the public and businesses,
3422 unresolved disruption of any of these lifelines can significantly impede a successful
3423 reopening. The FEMA Community Lifelines are categorized into the following groups:
3424

⁷⁷

3425 – Safety and Security

3426 – Food, Water, Shelter

3427 – Health & Medical

3428 – Energy

3429 – Communications

3430 – Transportation

3431 – HAZMAT

⁷⁶ ((FEMA), 2021)

⁷⁷ FEMA (2019) “Community Lifelines Implementation Toolkit 2.0”. Available online at:
www.fema.gov/sites/default/files/2020-05/CommunityLifelinesToolkit2.0v2.pdf

3432 **Table 22: Notional Classification of Areas for Reopening, Based on Residual Contamination**⁷⁸

Area Use Classification	Dose Guide	Example Permitted Activities
<p>Unrestricted use for residential activities (including agriculture, though compliance requirements might vary). Areas where evacuation orders and access restrictions are lifted, and the established goal(s) for radiation mitigation has been met.</p>	<p>15 mrem/year @ 24 hrs/day 365 days for 30 years</p>	<ul style="list-style-type: none"> ▪ Individuals can enter and live in the area. ▪ Maintenance, repair, and public and private transportation can resume. ▪ Business and social services can resume (e.g., grocery stores, food delivery, gas stations).
<p>Limited use for industry and recreation. Areas where evacuation orders and public access restrictions are lifted, and the established goal(s) for radiation mitigation has been met but the remaining radiation level remains higher than what is considered safe for unrestricted use.</p>	<p>Industrial, commercial, or business:</p> <ul style="list-style-type: none"> ▪ 15 mrem/year @ 8 hours/day ▪ 250 days/year for 25 years <p>Recreational:</p> <ul style="list-style-type: none"> ▪ 15 mrem/year @ 168 hours/year for 70 years 	<ul style="list-style-type: none"> ▪ Infrastructure repair work can resume with restrictions. ▪ Industrial, commercial, and recreational activities can resume with restrictions.
<p>No Access for the public and radiation exposure controls are necessary. Areas where evacuation orders and access restrictions will remain in effect for months and years to come.</p>	<p>No entry allowed</p>	<ul style="list-style-type: none"> ▪ Individuals are not permitted to enter the area. ▪ Cleanup crews working in the area must be screened regularly for radiation exposure and wear PPE.

- 3433 ▪ **Prioritize areas to reopen first:** If necessary, implement a prioritization process for phased
- 3434 reopening. Relevant factors to consider include:
 - 3435 ○ **Demographics & vulnerable populations:** Consider residents' relative need to
 - 3436 relocate to previously contaminated structures, access to resources needed for
 - 3437 relocation, and the need to maintain neighborhood/community identity and establish
 - 3438 socioeconomic equity in repopulation decisions, consistent with applicable law.

⁷⁸ Based on dose limits provided in EPA (1997) OSWER 9200-4.18. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.

- 3439 ○ **Critical infrastructure:** Reoccupy remediation zones or parts of zones that contain
3440 critical infrastructure, such as hospitals, power generation, municipal services, and
3441 business activities critical to the economic vitality of the affected area.

- 3442 ○ **Contiguous neighborhoods/buildings:** Reoccupy remediation zones that are adjacent
3443 to one another to reduce resources needed to establish and maintain physical
3444 barriers to enable control of access into contaminated areas not yet remediated,
3445 allow for more flexible access to public transportation routes, and connect
3446 neighborhoods to essential services across the jurisdiction. Opening areas in groups
3447 or tranches can be more convenient than opening areas on a patchwork basis.

- 3448 ■ **Publicize the progress of reopening activities:** Planners are encouraged to develop a centralized
3449 process for publicizing progress of building inspection and reopening activities, since this
3450 information will need to be communicated to public and private sector stakeholders. As time
3451 elapses, property ownership in the affected areas may transition to new owners. Jurisdictions
3452 should plan for this contingency and update tracking systems to accommodate changes in
3453 property ownership that occur while access to areas is restricted.

- 3454 ■ **Bring critical public safety services back online:** Additionally, jurisdictions should consider the
3455 phased reintroduction of necessary public safety services (such as law enforcement and fire
3456 protection) as areas are reopened. This may require changes in staffing and other resources if a
3457 significant time period has elapsed and personnel changes have occurred in the interim.

3458 **Activity 9.2: Conduct Repairs/Final Remediation and Prepare for Reopening**

- 3459 ■ **Track the status of properties based upon reopening goals:** Develop a Property Readiness
3460 Registry for residential and commercial buildings that tracks critical milestones in a property's
3461 path to reopening, including the status of radiation remediation, habitability, scope of damage,
3462 needed repairs, and certifications. Table 23 provides an example.
 - 3463 ○ This registry may be combined with or make use of the database developed to track
3464 area sustainment operations as discussed in Focus Area 6.

- 3465 ■ **Help connect residents with contractors:** Identify a list of certified contractors, builders, building
3466 safety evaluators, and inspectors and provide it to the entities responsible for directing
3467 repairs/final remediation activities required to meet reopening criteria as described in Activity
3468 9.1 ("responsible entities" may be government or private property owners, depending on the
3469 building or structure requiring repair).
 - 3470 ○ Examples of relevant data sources include the U.S. Small Business Administration,
3471 state and local departments of revenue and licensing, professional societies,
3472 labor/trade unions, businesses (e.g., Home Depot, Lowes), and online sources (e.g.,
3473 online yellow pages).

- 3474 ○ Leverage emergency reconstruction contracts and permitting mechanisms to
3475 accommodate fast-track contracting and permitting, as the situation permits based
3476 on established reopening criteria.

- 3477 ■ **Update fencing and access controls:** Revise the boundaries, signage, and fencing for areas that
3478 are scheduled to reopen.

- 3479 ○ Display reopening signs and cautionary information prominently on and near
3480 reopened properties and along boundaries of reopened areas. If there are activity
3481 restrictions on areas that will be reopened, this information should also be included
3482 on reopening signage.

- 3483 ○ Mark specific streets and roads as the selected routes to direct returning residents
3484 and traffic.

- 3485 ○ As necessary, install gates and boom barriers at key entry points and deploy
3486 personnel to conduct entry check (including checking for permits).

- 3487 ■ **Complete a final assessment:** Conduct a final assessment for habitability and other reoccupation
3488 requirements previously set.

3489 **Table 23: Notional Example of a Property Readiness Registry**

Property Parcel ID	Dweller Current Location	Address	Zone	Residual Radiation Classification	Damage Assessment from RDD	Habitability Assessment	Reoccupancy certification	Pending Actions	Estimated Time Before Reopening
120982	Temp shelter	56 1 st Ave	Residential-Urban	Unrestricted	Minor damage fixed	Assessed	No	Inspect, certify	2-6 months
120982	Relocated to another state	57 1 st Ave	Residential-Urban	Unrestricted	Minor damage remaining	Not assessed	No	Repair, inspect, certify	6-12 months
330094	Temp shelter	98 Industry Park Blvd	Industrial-Light	Limited	None	Assessed	Yes	Certify	Up to 2 weeks
278000	Relocated to another county	5709 8 Rural Trail	Residential-Rural	Restricted	Severe damage beyond repair	Not habitable	None	All restrictions remain, plan for potential rebuilding	12 months plus

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Recommended Resources:

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- *National Disaster Housing Strategy*. (FEMA, 2009)
www.fema.gov/pdf/emergency/disasterhousing/NDHS-core.pdf
- *Post-Disaster Building Safety Evaluation Guidance*. (FEMA, 2019)
www.fema.gov/sites/default/files/2020-07/fema_p-2055_post-disaster_buildingsafety_evaluation_2019.pdf.
- *FEMA Preliminary Damage Assessment Guide*. (FEMA, 2020)
www.fema.gov/sites/default/files/2020-07/fema_preliminary-disaster-assessment_guide.pdf.
- *Risk Assessment Guidance for Superfund: Volume 1- Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)* (EPA 1991)
<https://semspub.epa.gov/src/document/HQ/156739>
- *Preliminary Remediation Goals for Radionuclides on Outdoor Surfaces at Superfund Sites Calculator* (EPA/ORNL)
<https://epa-sprg.ornl.gov/>
- *EPA Protective Action Guides* (EPA)
<https://www.epa.gov/radiation/protective-action-guides-pags>
- *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination: OSWER No. 9200.4-18* (EPA, 1997)
<https://www.epa.gov/superfund/radiation-superfund-sites>

3512 Focus Area 10: Enable Long Term Recovery

3513 *Guidance:* Transition from near- and medium-term response and recovery operations to a focus on
3514 sustainable, comprehensive, and long-term recovery. Leverage existing disaster recovery tools,
3515 processes, and systems to develop the coordinating structures and processes needed to align
3516 efforts across a wide range of SLTT, federal, private sector, and non-governmental organizations and
3517 stakeholders. Emphasize cross-functional and cross-sector collaboration and cooperation.



3518 Recommended Planning Partners:

- 3519 ▪ Emergency management
- 3520 ▪ Public safety and first responders
- 3521 ▪ Public health
- 3522 ▪ Recovery Support Functions
- 3523 ▪ Economic development organizations
- 3524 ▪ Human and social service agencies and NGOs
- 3525 ▪ Disaster recovery organizations, donors, and foundations, including Voluntary
3526 Organizations Active in Disaster (VOAD) organizations
- 3527 ▪ Local/state/federal/tribal government leaders

3528 Introduction

3529 Focus Area 10 describes special considerations for long-term recovery from an RDD incident. Over
3530 the long term, recovery can be managed by leveraging the same systems and processes utilized for
3531 other types of disasters. At the national level, these systems and processes are outlined in the
3532 National Disaster Recovery Framework (NDRF). This Focus Area provides an alignment of the NDRF
3533 with key factors and issues that are likely to arise in the context of an RDD incident.

3534 Recovery activities necessitated by RDD events can include long-term housing assistance associated
3535 with relocation, long-term health monitoring programs for the affected population, and long-term
3536 environmental consequence management in contaminated areas. While extended (multi-year)
3537 relocation of affected populations may be a factor in some RDD events, permanent resettlement is
3538 not likely to be needed on a significant scale in most potential scenarios.

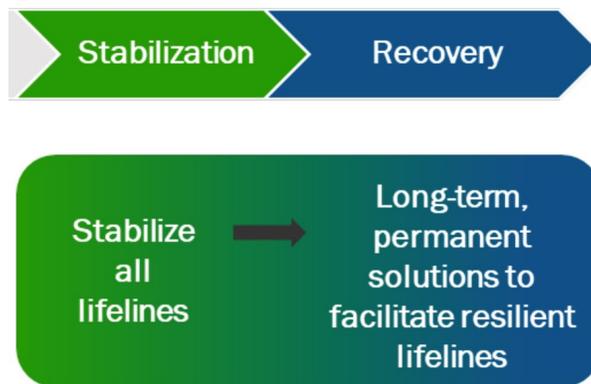
3539 The transition from emergency response to long-term recovery is accomplished by first stabilizing
3540 community lifelines. Then, existing pre-disaster recovery plans and processes can be mobilized and
3541 tailored, as needed, to kickstart the long-term recovery coordination process. The four key activities
3542 in this process are identified in Table 24 below.

3543 **Table 24: Summary of Focus Area 10 Activities**

	Activity	Phase
10.1	Transition from Incident Response and Lifeline Stabilization to Recovery	Intermediate (Days to Months)
10.2	Execute Existing Disaster Recovery Plans and Identify a Recovery Coordinating Structure	Intermediate (Days to Months)
10.3	Engage Stakeholders Representing Recovery Core Capability Groups	Intermediate to Late (Days to Years)
10.4	Manage Recovery Efforts by Leveraging Recovery Support Functions	Intermediate to Late (Days to Years)

3544 **Activity 10.1: Transition from Incident Response and Lifeline Stabilization to**
 3545 **Recovery**

- 3546 ▪ **Complete lifeline stabilization efforts:** As immediate emergency response and life safety
 3547 objectives are accomplished; operations will transition to incident stabilization efforts. Incident
 3548 stabilization is driven using the Community Lifelines model. In this approach, response
 3549 operations transition seamlessly to recovery operations through a structured process built
 3550 around the seven Community Lifelines: Safety and Security; Food, Water, and Shelter; Health and
 3551 Medical; Energy; Communications; Transportation; and HAZMAT. Figure 9 highlights this
 3552 transition.



3553
 3554 **Figure 9: Transition from Response (Stabilization) to Recovery (Source: FEMA Community**
 3555 **Lifelines Toolkit)⁷⁹**

⁷⁹ The FEMA Community Lifelines Toolkit can be found online at <https://www.fema.gov/emergency-managers/practitioners/lifelines-toolkit>

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- **Engage the whole community to prioritize recovery efforts:** It is important to emphasize that the focus of the recovery process is “community” recovery, which includes activities in support of the affected population as well as activities in support of affected local governments, businesses, and critical infrastructure operators. To begin recovery operations, emergency managers should proactively engage the private sector, NGOs, and local government officials across relevant agencies to determine what special concerns and considerations should be addressed based on the specific impacts and protective actions that apply to the RDD incident.
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- **Prepare recovery stakeholders to adopt a “recalibrated” posture:** In an RDD scenario, emergency managers will work with responding agencies to identify and address longer-term lifeline impacts in the same or similar manner that would occur for any other significant event. However, there are special factors in an RDD incident that should be given additional consideration.
 - Specifically, these factors are related to the prolonged evacuation or relocation requirements that may be associated with an RDD incident. In most cases, evacuees and survivors begin to re-enter affected disaster areas as soon as the immediate threat has abated. However, in an RDD scenario, re-entry may not be possible for weeks or years. This means that long-term support of the relocated population will require a recalibration of existing disaster recovery plans and processes.
 - Recovery stakeholders should be aware that assistance may need to be provided on a continual basis for an extended period of time. This assistance is unusual, because most assistance programs are usually intended to remain in place only long enough for the community to return to “baseline” and for individuals to re-establish themselves in their prior residences as quickly as possible. Agencies accustomed to providing assistance for a period of 4-6 weeks may now be required to sustain that assistance for 4-6 months (or longer), for example. Similarly, when working with an evacuated or relocated population, agencies accustomed to providing services at individual affected residences might need to adapt their procedures and processes to offer services at shelters, temporary housing sites, or temporary residences (such as for evacuees who choose to stay with family and friends outside the affected area).
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- **Identify and employ bridging resources and solutions:** In addressing community lifeline impacts, temporary resources may be deployed or activated to “bridge” the response over the near-term until a more viable solution can be identified and implemented for medium- and long-term recovery to progress. Additional concerns based on the unique circumstances of an RDD incident may impact the choice of bridging solutions used to stabilize the lifelines until long-term recovery can be substantially accomplished, a process generally requiring months to years. Some notional examples of these factors are included in Table 25 below.
- 3592
- 3593
- 3594
- **Transition responsibility for recovery from the emergency response organization to the disaster recovery organization.** Once lifelines have been stabilized and essential services restored (even if in a modified manner or in a way that serves a population that has now been evacuated,

3595 relocated, or dispersed), the emergency response coordinating structure should make a
 3596 deliberate handoff of responsibility to the disaster recovery coordinating structure. This transition
 3597 will include (for example) transitioning responsibility for services and functions that have been
 3598 affected by the RDD incident from the EOC to the Local Disaster Recovery Manager (LDRM) and
 3599 the disaster recovery coordinating structure.

3600 **Table 25: Example Lifeline Stabilization Factors for an RDD Incident**

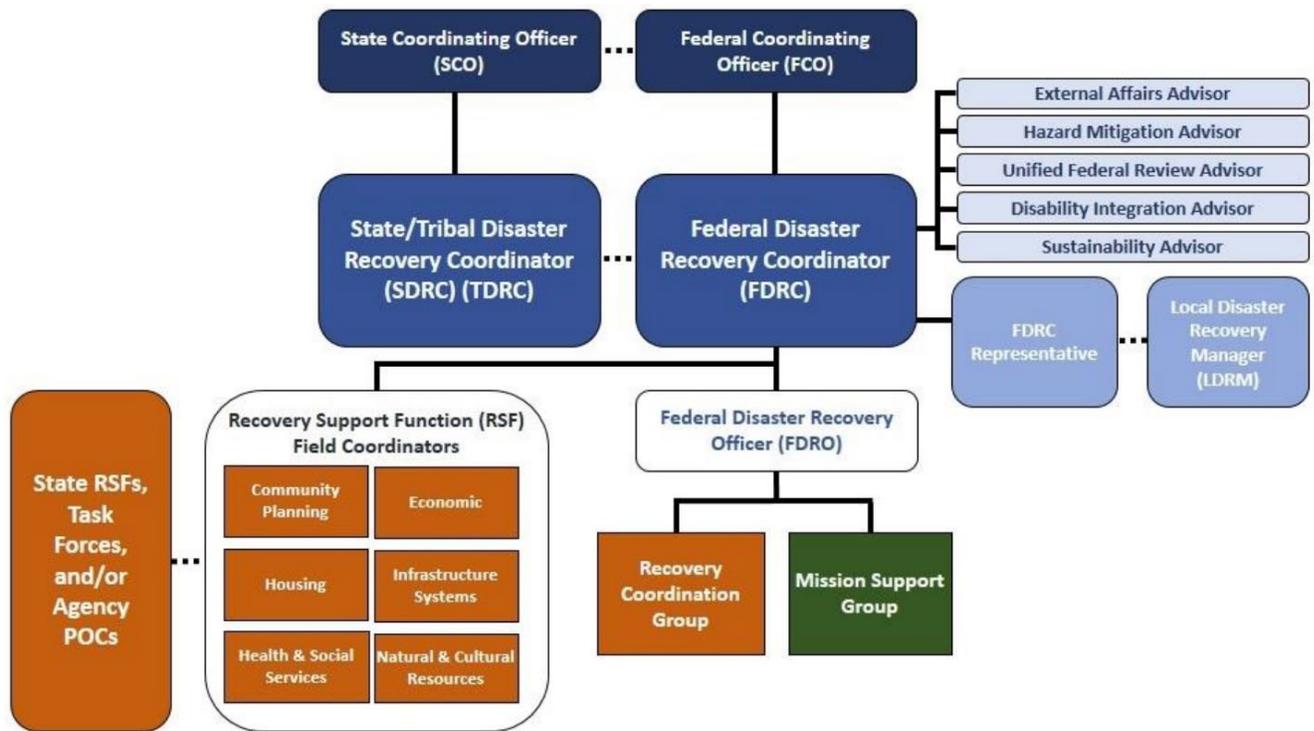
Lifeline	Example Impacts and RDD-related Factors	Example Stabilization Strategies	Example Bridging Resources and Actions
Safety and Security	<ul style="list-style-type: none"> ▪ Disruption of fire, law enforcement, and EMS coverage ▪ Overwhelming of the 911 system ▪ Loss of access to vital records 	<ul style="list-style-type: none"> ▪ Temporary curtailment or relocation of essential emergency services ▪ Establishment of dedicated hotlines and call-centers for RDD event-related information 	<ul style="list-style-type: none"> ▪ Provision of temporary public safety facilities ▪ Medium-term (weeks to months) mutual aid and backfill personnel for critical public safety functions ▪ Private sector contract support to provide telephone and internet support for affected individuals
Food, Water, and Shelter	<ul style="list-style-type: none"> ▪ Loss of access to routine suppliers of food and basic commodities for evacuated and relocated individuals ▪ Possible ingestion pathway concerns related to radiological contamination ▪ Loss of access to housing 	<ul style="list-style-type: none"> ▪ Food assistance for evacuated and relocated populations ▪ Curtailment of agriculture in contaminated areas ▪ Shelter operations for evacuated populations 	<ul style="list-style-type: none"> ▪ D-SNAP temporary food assistance ▪ Provision of temporary housing for populations evacuated for an extended period or who must relocate until radiation remediation objectives have been achieved
Health and Medical	<ul style="list-style-type: none"> ▪ Injuries/mental health effects due to direct and indirect effects of the RDD event ▪ Loss of access to pharmacies and medical providers due to evacuation or relocation 	<ul style="list-style-type: none"> ▪ Establishment of expedient survivor tracking systems and processes for long term health surveillance purposes ▪ Provision of alternate facilities and capabilities to 	<ul style="list-style-type: none"> ▪ Disaster Medical Assistance Team (DMAT) augmentation for hospital decompression and standalone clinics ▪ Temporary transportation solution to help individuals access out-of-area to

Lifeline	Example Impacts and RDD-related Factors	Example Stabilization Strategies	Example Bridging Resources and Actions
Energy	<ul style="list-style-type: none"> Evacuation or relocation of critical facilities (e.g., hospitals and nursing homes) affected by the event 	<ul style="list-style-type: none"> provide medical care and/or pharmaceutical supply 	<ul style="list-style-type: none"> receive medical care for chronic/routine conditions Private sector contract support for survivor tracking and surveillance
	<ul style="list-style-type: none"> Loss of access to critical energy facilities (e.g., ports or refineries) affected by the event 	<ul style="list-style-type: none"> Utilization of alternative energy suppliers Gross decontamination of infrastructure/area 	<ul style="list-style-type: none"> Provision of temporary fuel depots Re-routing fuel and energy flows Extended generator use
Communications	<ul style="list-style-type: none"> Loss of access to critical communications nodes Loss of access to financial facilities like banks 	<ul style="list-style-type: none"> Coordination with public and private sector telecommunications providers to alter capabilities and wireless coverage 	<ul style="list-style-type: none"> Utilization of federal emergency communications support capabilities (e.g., Mobile Emergency Response Support (MERS)) Deployment of temporary communications systems for weeks-months
Transportation	<ul style="list-style-type: none"> Loss of access to transportation capabilities such as surface buses and subway systems 	<ul style="list-style-type: none"> Provision of alternate transportation 	<ul style="list-style-type: none"> Utilization of mutual aid and private sector resources Re-tasking of existing transportation resources
Hazardous Materials	<ul style="list-style-type: none"> Loss of access to critical controlled industrial chemical processes and storage areas 	<ul style="list-style-type: none"> Render-safe operations for hazmat to remain in place Temporary relocation of hazmat and transport to alternate facilities 	<ul style="list-style-type: none"> Utilization of mutual aid and private sector resources

3601 **Activity 10.2: Execute Existing Disaster Recovery Plans and Identify a**
3602 **Recovery Coordinating Structure**

- 3603 ▪ **Leverage existing recovery plans and processes:** Most local communities maintain a pre-disaster
3604 recovery plan. Developed to be consistent with SLTT and federal guidance, these recovery plans
3605 outline roles and responsibilities such as the designation of a LDRM or equivalent disaster
3606 recovery coordinator. Frequently, a coordinating structure relying on a steering committee or
3607 recovery planning committee is also utilized. These plans identify the stakeholders and
3608 processes to be utilized in disaster recovery. It will benefit the RDD recovery process to leverage
3609 these plans and processes wherever possible, tailoring them to address the unique concerns
3610 associated with a radiological incident.
- 3611 ▪ **Initiate recovery planning and coordination.** Most disaster recovery planning begins before the
3612 disaster occurs and relies upon projections and assumptions of likely disaster impacts, such as
3613 for a flood or a hurricane. An RDD scenario is likely to be a “no-notice” event, meaning there is
3614 little opportunity to conduct detail-level recovery planning before the event occurs. Recovery
3615 stakeholders will engage immediately to meet urgent needs, but will likely require additional
3616 data, modeling, and analysis of the RDD incident’s impacts, along with other technical inputs, to
3617 support medium- and long-range recovery planning. In the early phases of an RDD incident, the
3618 number of “unknowns”—such as information about contamination levels, plans for evacuating
3619 and relocating affected individuals, and plans for remediation activities and activities by law
3620 enforcement in areas designated as crime scenes—may limit or forestall more long-range and
3621 comprehensive recovery planning efforts. In an RDD scenario, identifying and quantifying these
3622 unknowns will inform communications with subject matter experts and response officials to
3623 gather the information and intelligence necessary to support the recovery planning process.
- 3624 ▪ **Identify a recovery coordinating structure.** As previously mentioned, most communities have a
3625 pre-defined disaster recovery coordinating structure outlining roles and responsibilities for key
3626 stakeholders and organizations.
- 3627 ○ At the federal level, a Federal Disaster Recovery Coordinator (FDRC) may be assigned
3628 to work under the auspices of the Federal Coordinating Officer (FCO). The FDRC
3629 would take the role of coordinating and streamlining efforts across all involved
3630 federal organizations and would take over responsibility from the incident gradually
3631 as the FCO accomplishes emergency response objectives over time. This structure is
3632 frequently mirrored at the state/tribal/territorial level with the appointment of a
3633 State, Tribal, or Territorial Disaster Recovery Coordinator (SDRC/TDRC). An example
3634 of this coordinating structure is provided in Figure 10 below. In addition, depending
3635 on the nature and extent of the damage from the incident, the federal government

- 3636 may have established a unified coordination group to assist in the response and
 3637 recovery efforts.⁸⁰
- 3638 ○ Given that an RDD incident is likely to encompass an extended time horizon for long-
 3639 term recovery, early appointments of FDRCs and SDRC/TRDRs are recommended.
- 3640 ○ At the local level, pre-existing disaster recovery plans and processes should be
 3641 rapidly reviewed to determine their feasibility for managing a complex, intensive, and
 3642 lengthy disaster recovery process. Factors to consider include designation of full-time
 3643 recovery coordinators for an RDD incident instead of relying exclusively on other
 3644 personnel such as emergency managers who might traditionally perform LDRM
 3645 duties in an expansion of their existing roles.
- 3646 ○ Even though an RDD event may be small in its total area of geographic impact, it is
 3647 likely to garner a significant amount of attention. This attention means that even a
 3648 “small” event could involve recovery coordination requirements equivalent to or
 3649 larger than an extremely large regional disaster or Type 1 incident.



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 3651 **Figure 10: Interagency Recovery Coordination Structure (Source: FEMA, Recovery FIOP)⁸¹**

⁸⁰ See Response and Recovery FIOP, pp. 10-15 (1st ed. March 2023)

⁸¹ The FEMA Recovery Federal Interagency Operation Plan (FIOP), 2016, can be found online at: https://www.fema.gov/sites/default/files/documents/fema_recovery-fiop.pdf

3652 **Activity 10.3: Engage Stakeholders Representing Recovery Core Capability**
 3653 **Groups**

- 3654 ▪ **Identify stakeholders for recovery core capability delivery:** The NDRF relies upon coordination of
 3655 recovery core capabilities through a Recovery Support Function (RSF) structure. In an RDD
 3656 incident, recovery capabilities are likely to be employed for an extended period of time and in
 3657 circumstances different from other hazards such as hurricanes or wildfires.
 - 3658 ○ Identifying stakeholders and organizations that can support recovery capabilities will
 3659 be crucial for ramping up long-term recovery efforts. Recovery core capabilities are
 3660 defined in the NDRF; a crosswalk with likely RDD considerations is provided in Table
 3661 6.

- 3662 ▪ **Determine which entities have a vested or regulatory interest in the recovery process.** Recovery
 3663 capabilities include those organizations that have statutory, regulatory, or rules-based
 3664 responsibilities and/or resources relevant to a particular disaster, including an RDD incident. For
 3665 example, vested or interested entities could include, but is not limited to, historical and
 3666 environmental protection agencies, cultural and heritage organizations, economic development
 3667 entities, planning commissions and zoning authorities, and other organizations that have
 3668 requirements for mandatory permitting, consulting, or approvals for recovery work to proceed. In
 3669 an RDD incident, some of these entities may have modified or expanded roles. Identifying the
 3670 degree to which each stakeholder across all the capabilities has a specific role related to the
 3671 unique circumstances of the RDD event will be crucial to developing a streamlined and efficient
 3672 recovery coordination process.

- 3673 ▪ **Align processes and procedures.** Where possible, regulatory and permit-granting organizations
 3674 should be encouraged to coordinate, consolidate, and streamline processes, record-keeping, and
 3675 contact with survivors and other recovery stakeholders to provide a simplified recovery process
 3676 flow. This alignment is even more important given a scenario in which survivors have been
 3677 relocated outside of the affected areas and will likely be required to interact with many SLTT and
 3678 federal agencies.

3679 **Table 26: Potential RDD Considerations for Recovery Core Capabilities**

Recovery Core Capability	Potential RDD Considerations
Planning	May require professional planning support that can integrate with the technical aspects of the radiological HAZMAT optimization and remediation processes.
Public Information and Warning	May require extended commercial support for the maintenance of telephone and internet customer service-like portals for affected individuals, if large in number. May require augmentation to keep track of individuals who have evacuated or relocated out of the affected jurisdiction.

Recovery Core Capability	Potential RDD Considerations
Operational Coordination	Recovery planning is likely to be intensive and extend for a long time. Professional support in designing, managing, and facilitating the recovery coordinating structure and its business processes may be appropriate.
Economic Recovery	Given the potential for substantial economic impacts from an RDD incident, expertise in coordinating with the private sector (beyond the more traditional disaster recovery functions) may be needed. Additionally, specific matters associated with insurance coverages and various government assistance programs may require the engagement of subject matter experts and non-routine disaster recovery organizations.
Health and Social Services	Challenges with providing longer-term health and social services could be related to (1) the particular risks associated with an RDD incident, as well as (2) technical expertise and capabilities necessary to serve the affected population.
Housing	An RDD incident could potentially generate a requirement for extended disaster housing assistance in an area not otherwise accustomed to performance of a direct housing mission
Infrastructure Systems	Coordination of infrastructure stakeholders in support of the remediation and recovery processes will likely require substantial effort and bandwidth beyond that typically involved for a natural disaster of equivalent impact.
Natural and Cultural Resources	Ecological and environmental considerations in an RDD incident may substantially drive the involvement of natural and cultural resources entities beyond that traditionally encountered in a natural disaster.

3680 **Activity 10.4: Manage Recovery Efforts by Leveraging the Recovery Support**
 3681 **Functions**

- 3682 ▪ **Plan for extended recovery operations.** RDD incident recovery may last for years. It is important
 3683 to take this long-term operation into consideration at the very beginning of recovery planning
 3684 efforts, so that relevant structures, systems, and processes can be established to endure for a
 3685 significant period of time.

- 3686 ▪ **Utilize the recovery coordinating structure to interface with recovery support functions (RSF’s) at**
 3687 **the state/tribal/territorial and federal levels.** The RSF structure provides the mechanism for
 3688 aligning efforts across all interested parties and stakeholders to accomplish recovery objectives
 3689 as supported via recovery core capabilities. In other words, each RSF represents a different
 3690 group of organizations, all of which share different capability sets within their respective areas of
 3691 responsibility. The RSFs are listed in Table 7.
 - 3692 ○ In an RDD scenario, where complex challenges are likely to be encountered and
 3693 endure for extended periods (years), leveraging the RSF structure to coordinate
 3694 activities among interested parties can provide a robust, enduring, trackable, and
 3695 manageable means to identify, troubleshoot, and solve problems.

- 3696 ▪ **Provide education and orientation for recovery stakeholders about the longer-term radiological**
 3697 **hazards presented by an RDD incident.** Many organizations participating in the recovery process
 3698 will have minimal to no technical expertise in radiological event response and recovery. For the
 3699 recovery process to proceed with efficiency and integrity, consider providing a baseline training
 3700 and orientation about radiological hazards (and especially the unique facts and circumstances of
 3701 the RDD event in question) to attain a common level of awareness. This training is likely to be a
 3702 useful measure to prevent misunderstandings and miscommunications, especially during the
 3703 early phases of recovery.

- 3704 ▪ **Expand RSF participation to include representatives of organizations beyond the immediate RDD**
 3705 **impact area.** An RDD incident of significance is likely to generate second- and third-order effects
 3706 far beyond the detonation site, contaminated areas, or evacuation/relocation zones. This may be
 3707 due to multiple factors including stigma associated with radiological contamination, interruption
 3708 of essential services and infrastructure, or loss of access to critical facilities in the affected area
 3709 that serve a much larger population in a broader region. Additionally, even though an RDD
 3710 incident may be hyper-localized in its physical impacts and effects, it may have a psychological
 3711 impact on a much broader area. For this reason, it is advisable to proactively engage regional
 3712 stakeholders early in the recovery process by incorporating them into the appropriate RSF
 3713 coordinating groups.

3714 **Table 27: RSF – RDD Incident Crosswalk**

Recovery Support Function	Description and RDD Special Considerations
Community Planning and Capacity Building	<ul style="list-style-type: none"> ▪ Focuses on coordinating planning efforts. ▪ RDD Considerations: May involve a period of technical orientation and education among stakeholders regarding the specific hazards, risks, and challenges associated with a radiological incident, as well as a learning curve for understanding and interpreting technical data and reports such as dose assessments, the optimization process, and modeling.
Economic Recovery	<ul style="list-style-type: none"> ▪ Focuses on addressing and mitigating impacts to the financial/commercial prosperity and vigor of the affected area’s economy. ▪ RDD Considerations: Will likely entail extensive, direct, and targeted outreach on behalf of the recovery coordinating structure to engage with affected business, commercial, and private sector entities in the RDD impact area. This will necessarily include a liaison role on behalf of business and economic development interests to the rest of the recovery coordinating group, and could include facilitation of educational outreach and training for businesses about the radiological event and the technical aspects of its impact and the recovery process
Health and Social Services	<ul style="list-style-type: none"> ▪ Focuses on providing medical, social, welfare, and other adjacent support functions to individuals, households, families, and children.

Recovery Support Function	Description and RDD Special Considerations
	<ul style="list-style-type: none"> ▪ RDD Considerations: Where disruption to health and social services agencies has occurred due to interruption of activities or relocation from existing facilities, coordination with other RSFs likely will be needed to ensure consistency and maintenance of a baseline level of support services to the affected population. Note that health and social services agencies may serve a large population in a geographic area exceeding that impacted directly by the RDD incident. In this case, the served population in this greater area of indirect impact could potentially increase the number of individuals impacted by the RDD incident several fold. One example is the loss of access to a critical facility like a hospital and the cascading impacts of that contingency on the surrounding areas. Additionally, people who were exposed to radiation contamination during the incident will need to participate in a long-term population monitoring program to enable identification and mitigation of enduring health effects associated with such exposure.
Housing	<ul style="list-style-type: none"> ▪ Focuses on providing housing solutions to individuals displaced by a disaster or who are without access to adequate/safe housing. ▪ RDD Considerations: In a relocation scenario, an RDD incident is likely to generate the requirement for a direct housing mission (provision of temporary residences by a governmental entity like a state or FEMA). Even in an evacuation-only scenario, housing challenges such as loss of access to check for damages or to manage utilities and services could generate cascading effects in terms of housing repair/replacement requirements.
Infrastructure Systems	<ul style="list-style-type: none"> ▪ Focuses on maintenance and restoration of critical infrastructure and related services in the affected area. ▪ RDD Considerations: While direct impacts to infrastructure in a typical RDD scenario may be limited, second-order effects could generate longer-term infrastructure damage and failures, as well as longer-term health impacts on essential workers in critical infrastructure industries. As with other areas of concern, this can be related to both loss of access to critical systems as well as particular variables associated with an RDD incident impacting infrastructure systems like water systems, subway transportation, etc.
Natural and Cultural Resources	<ul style="list-style-type: none"> ▪ Focuses on providing cultural services during the recovery process as well as compliance with cultural and environmental rules and regulations. ▪ RDD Considerations: An RDD incident likely will present long-term environmental challenges. Remediation activities may generate significant quantities of radioactive waste that must be transported and stored in designated locations. Proactive engagement of cultural and environmental stakeholder organizations through this RSF is advisable to deconflict overlapping interests and avoid potential pitfalls throughout the recovery process.



Recommended Resources:

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- National Disaster Recovery Framework (NDRF) (FEMA)
<https://www.fema.gov/emergency-managers/national-preparedness/frameworks/recovery>
- Community Lifelines Implementation Toolkit (FEMA)
<https://www.fema.gov/emergency-managers/practitioners/lifelines-toolkit>
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Annex A: Glossary of Terms

Term	Definition
1 km Transect	An initial survey at approximately 1 km from the point of release that is orthogonal to the prevailing wind direction. It is used to establish an indication of long-range contamination and to gather information on the location of the point of highest concentration to locate the actual plume centerline.
10-Point Monitoring Plan	An early and coherent set of field measurements to help local first responders prioritize subsequent monitoring of affected areas and provide data that are needed to refine dispersion modeling of deposition and dose projections for early protective action decision-making.
Agreement State	39 states in the United States that have signed an agreement with the NRC authorizing the state to regulate certain uses of radioactive materials within the state. Through the agreement, the states have the authority to license and inspect byproduct, source, or special nuclear materials used or possessed within their borders. Further information at: https://www.nrc.gov/about-nrc/state-tribal/agreement-states.html .
ALARA	As <u>L</u> ow <u>A</u> s <u>R</u> easonably <u>A</u> chievable (ALARA); radiation safety concept for minimizing dose.
Background Radiation	The natural radiation that is always present in the environment. It includes cosmic radiation which comes from the sun and stars, terrestrial radiation which comes from the Earth, and internal radiation which exists in all living things. The typical average individual exposure in the United States from natural background sources is about 300 millirem per year.
Certified Health Physicist	An individual that has completed all the necessary requirements (education, experience, and 2-part examination) to be granted professional certification in the field of health physics (radiation safety) by the American Board of Health Physics.
Cleanup level	The radionuclide-specific activity concentration in a media (such as soil) agreed to by regulators and stakeholders that is appropriate for future land use and is protective of human health and the environment. The cleanup level may be set to meet a risk level (e.g., 1 in 10,000 to 1 in 1,000,000 (10^{-4} - 10^{-6}) increased lifetime risk of getting cancer, based on EPA's Superfund cleanup regulations) or dose-based (e.g., 25 mrem/yr total effective dose equivalent, based on NRC's 10 CFR 20.1402).
Community lifeline	A lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security. Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function.

Term	Definition
Community Reception Centers (CRCs)	A physical space that provides contamination screening and decontamination services to people displaced by a large-scale radiation incident. CRCs are established to assess people for exposure, contamination, and the need for decontamination and to register people for monitoring, radiological assessment, or medical management if necessary.
Community Reception Center (CRC) Toolkit	Includes staffing requirements, necessary equipment lists, forms, and electronic applications for use in CRC operations:
Contaminated Area	Consists of any place where radionuclides are on a surface or in the environment as a result of a release. For practical purposes, a baseline, above which an area is considered to have meaningful contamination, should be determined in advance, and then be re-assessed after an incident. Designation of the contaminated area will inform identification of areas that require remediation, as well as exposure mitigation actions to protect the public and responders.
Contamination	<p>The National Fire Protection Association’s Hazardous Materials Response Handbook defines contamination as “the direct transfer of hazardous material.” Radioactive contamination is radioactive material where its presence is unwanted or unexpected.</p> <p>External: Unwanted radioactive material on the outside of the body, on the clothing, skin, hair, or body cavities such as the outer ear and eye.</p> <p>Internal: Unwanted radioactive material within the body following absorption through the skin, ingestion, inhalation, or through wounds.</p>
Critical Infrastructure (CI)	Includes equipment, buildings, systems, and networks that provide key services to the public and are vital to public health and safety. Critical infrastructure includes transportation infrastructure, telecommunications infrastructure, hospitals and medical facilities, power plants, and emergency services, among others
Dangerous Radiation Zone (DRZ)	For radiological safety, the Dangerous Radiation Zone is defined by the National Council of Radiation Protection and Measurements (NCRP) as an area where radiation levels exceed 10 R/hr (0.1 Gy/hr).

Term	Definition
Decontamination	<p>The reduction or removal of radioactive contamination from a structure, object, or person. See DOE’s <i>Radiological Control Manual</i>.</p> <p>Gross Decontamination: Gross decontamination typically refers to non-targeted methods that remove large amounts of contamination, but may not ensure 100% removal, such as removing clothing and showering or hosing stations without run-off collection.</p> <p>Technical Decontamination: Decontamination designed to reduce contamination to very low levels, typically close to background radiation levels. This level of decontamination may not be necessary for all scenarios and requires radiation detection equipment to confirm the success of decontamination.</p> <p>Self-Decontamination: Decontamination carried out by individuals by themselves. Self-decontamination could include removal of outer layers of clothing, showering, or other methods.</p> <p>Ad hoc Screening and Decontamination: Ad hoc screening and decontamination refer to the onsite and early screening and decontamination activities discussed in the <i>First 100 Minutes Guidance</i> as well as in Focus Area 4 (Evacuation). These screening and decontamination activities primarily exist to address early demand at or near the response and may rely entirely on gross decontamination. CRCs are designed to provide more services than ad hoc locations but take more time and resources to set up and operate.</p>
Derived Concentration Guideline Level (DCGL)	<p>A derived, radionuclide-specific activity concentration within a <i>survey unit</i> corresponding to the <i>release criterion</i>. DCGLs are derived from activity/dose relationships through various <i>exposure pathway</i> scenarios.</p>
Detonation Site	<p>The immediate area surrounding the detonation point out to 20-meters, cordoned off and left undisturbed unless entry is necessary for immediate life safety needs. Note: This site may be initially larger if dose rates exceed 10 R/hr (0.1 Gy/hr).</p>
Disinformation	<p>Deliberately created false information with the intention of misleading, harming, or manipulating a person, social group, organization, or country.</p>
Dose Assessment	<p>Systematic process to assess the amount of radiation energy (ionizing radiation) absorbed by an object or person per unit mass. Used to determine the potential health risk for people in the area and inform short-term mitigation actions (e.g., setting PAGs) as well as long-term mitigation actions (e.g., DCGL and cleanup levels). Dose assessments are tailored for person(s) receiving potential exposure (e.g., firefighter, remediation worker or someone living miles away from the contamination areas) and as such, can be retrospective or prospective.</p>

Term	Definition
Dosimetry	The theory and application of the principles and techniques involved in measuring and recording doses of ionizing radiation. ⁸² Also refers to the measurement equipment given to individuals specifically to measure radiation dose to that individual.
Early Phase	The beginning of a radiological incident for which immediate decisions for effective use of protective actions are required and must therefore be based primarily on the status of the radiological incident and the prognosis for worsening conditions. This phase may last from hours to days.
Explosive Hazards Exclusion Zone	Determined by the responding Public Safety Bomb Technician, the area where explosive effects (heat, shockwave, fragmentation) will be affected based upon the suspected estimated net explosive weight in any suspected secondary devices. This area is normally cordoned off by law enforcement personnel and only bomb technician personnel are allowed into this area until cleared. For planning purpose, these zones are initially 300m in diameter until further is known about the hazardous device.
Exposure Pathway	The route by which radioactivity travels through the environment to eventually cause radiation exposure to a person or group. Pathways in the environment include air, water, and soil. Exposure pathways into a person include inhalation, ingestion, injection, and dermal exposure. Dose assessments use the exposure pathway in analyzing the dose to a person.
External Radiation	A source located on or outside the body that emits radiation that penetrates the epidermis and irradiates organs and tissues.
Evacuation	There are two evacuation terms to be aware of: time-phased evacuation: A time-phased evacuation is an evacuation according to a time schedule. Scheduling involves making decisions regarding the allocation of available capacity or resources (equipment, labor, and space) over time. Scheduling thus results in a time-phased plan, or schedule of activities. The schedule indicates what is to be done, when, by whom and with what equipment phased and prioritized evacuation: A phased and prioritized evacuation is an evacuation that is conducted in the order or sequence that evacuates those in the highest risk category (from all hazards or medical conditions) first, followed by those in a decreasing risk order.
FSLTT	Federal, state, local, tribal, and territorial recovery agencies

⁸² NRC (2021) *Dosimetry*. Available online at: <https://www.nrc.gov/reading-rm/basic-ref/glossary/dosimetry.html>

Term	Definition
Gamma Spectroscopy	Quantitative measure of the energy spectra of gamma-emitting sources. There are a wide variety of gamma spectroscopy instruments, ranging from portable radionuclide identification devices (RIID) often carried by emergency responders to specialized high purity germanium (HPGe) detectors. Instruments are critical in evaluating the radiation dose rate at locations that are contaminated as well as conducting background measurement in a non-contaminated area.
Groundshine	External radiation from the fallout of radioactive particles deposited on the ground after passage of the aerosol plume.
Hazardous Waste	Waste with properties that make it dangerous or potentially harmful to human health or the environment, which is why it is so strictly regulated. Such waste can be liquids, solids, contained gases, or sludges. Hazardous wastes are either specifically listed as hazardous by EPA or a state or exhibit one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. Hazardous waste is regulated under the Resource Conservation and Recovery Act (RCRA) Subtitle C (See RCRA hazardous waste for the regulatory definition). From https://www.epa.gov/report-environment/wastes#:~:text=Many%20different%20types%20of%20waste,fo ssil%20fuel%20combustion%20waste%2C%20and; https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes .
Hot Spot	Any place where the level of radioactive contamination is considerably greater than the area around it.
Hot Zone	For radiological safety, the hot zone is defined by the National Council of Radiation Protection and Measurements (NCRP) as an area where radiation levels exceed 10 mR/hr (0.1 mGy/hr) or 60,000 dpm/cm ² beta and gamma at 1.5 cm (~0.5 inch) and 6,000 dpm/cm ² at 0.5 cm (~0.25 inch) with an alpha probe. Alpha probes should include predetermined conversion factors from cpm to dpm/cm ² .
Intermediate Phase	The period beginning after the source and releases have been brought under control (has not necessarily stopped but is no longer growing) and reliable environmental measurements are available for use as a basis for decisions on protective actions and extending until these additional protective actions are no longer needed. This phase may overlap the early phase and late phase and may last from weeks to months.

Term	Definition
Land Use	<p>Land use” is the term used to describe the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place.”</p> <p>Residential land use is an area that is zoned by the municipality for single-family or multifamily dwellings where businesses may or may not be conducted in the dwellings. - Industrial, Commercial, Business land use include areas designated for more intense operations and traffic.</p> <p>Recreational land use is typically owned by the municipality that are designated public areas, excluding residential dwellings. Agricultural land use is an area that includes residential areas as well as production of food that could be consumed by humans (an exposure pathway for consideration in dose assessments).</p>
Late Phase	<p>The period beginning when recovery actions designed to reduce radiation levels in the environment to acceptable levels are commenced and ending when all recovery actions have been completed. This phase may extend from months to years. A PAG level, or dose to avoid, is not appropriate for long-term cleanup.</p>
Low Level Radioactive Waste (LLRW) Disposal Facility	<p>LLRW destined for disposal must be transported to a commercially operated low-level radioactive waste disposal facility that is licensed by either the Nuclear Regulatory Commission (NRC) or by an Agreement State. LLRW disposal facilities must be designed, constructed, and operated to meet safety standards. The operator of the facility must also extensively characterize the site on which the facility is located and analyze how the facility will perform for thousands of years into the future.</p>
Malinformation	<p>Information based in fact but used out of context to mislead, harm, or manipulate. An example of malinformation is editing a video to remove important context to harm or mislead.</p>
MARSSIM	<p>The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides detailed guidance on how to demonstrate that a site is in compliance with a radiation dose- or risk-based regulation (federal or state regulations). MARSSIM focuses on the demonstration of compliance during the final status survey following scoping, characterization, and any necessary remedial actions. Agencies that collaborate on MARSSIM include EPA, Nuclear Regulatory Commission, Department of Energy and Department of Defense.</p>
Misinformation	<p>False information that was not created or shared with the intention of causing harm.</p>
Mitigation	<p>Capabilities necessary to reduce loss of life and property by lessening the impact of disasters. Mitigation capabilities include, but are not limited to, community-wide risk reduction projects; efforts to improve the resilience of critical infrastructure and key resource lifelines; risk reduction for specific vulnerabilities from natural hazards or acts of terrorism; and initiatives to reduce future risks after a disaster has occurred.</p>

Term	Definition
Mixed Waste	Waste that has a hazardous component and a radioactive component is called “mixed waste.” The hazardous component of the mixed waste is regulated by EPA under RCRA. The radiological component of the mixed waste is regulated by DOE or NRC.
Near Field	The area surrounding the detonation point out to 500 meters and 1 kilometer downwind
Optimization ⁸³	The source-related process to keep the magnitude of individual doses, the number of people exposed, and the likelihood of potential exposure as low as reasonably achievable below the appropriate dose constraints, with economic and social factors being considered.
PAG	Protective Action Guide (PAG) is defined as the projected dose to an individual, resulting from a radiological incident at which a specific protective action to reduce or avoid that dose is warranted.
Plume	The column or cloud of smoke emanating from the mount of a continuously emitting chimney or smokestack is called a plume. In the case of an explosive RDD, the plume would be due to a “puff” release of material.
Population Monitoring	The process of evaluating and monitoring a population for radiologically related medical treatment, the presence of radioactive contamination on an individual’s clothing or body (external contamination), intake of radioactive materials (internal contamination), radiation dose received, resulting health risk, and long-term health effects.
Public Safety Bomb Squad	A federal, state, local, tribal, or territorial bomb response team accredited by the FBI's Hazardous Devices School.
Public Safety Bomb Technician	A graduate of the FBI's Hazardous Devices School (HDS) bomb technician course with a current certification from HDS and assigned to a bomb response team.
Radiation Exposure	The quantity of energy absorbed in a tissue or organ from either an external radiation source or from radionuclides in the body.
Radiological Operations Support Specialist (ROSS)	An individual with radiological expertise and an understanding of the Incident Command System (ICS) available to state, local, tribal, and territorial emergency managers, responders, and decision-makers. ROSS are FEMA-typed and can be requested through mechanisms such as the Emergency Management Assistance Compact (EMAC).

⁸³ ICRP (2006). “ICRP Publication 101b: The Optimisation of Radiological Protection: Broadening the Process.” Available online at: <https://www.icrp.org/publication.asp?id=ICRP%20Publication%20101b>

Term	Definition
Radiation Technical Working Groups (R-TWGs)	A group of Subject matter experts, selected by the unified command (UC), that: “provides multi-agency, multi-disciplinary expert input on the cleanup options analysis, including advice on technical issues, analysis of relevant regulatory requirements and guidelines, risk analyses, and development of cleanup options.” The technical working group provides expert technical input to the UC; it is not part of the decision-makers. (p. 76)
Radioactivity	The property possessed by some elements (such as uranium) of spontaneously emitting energy in the form of radiation as a result of the decay (or disintegration) of an unstable atom. It is the rate at which radioactive material emits radiation. Radioactivity is measured in curies (Ci), becquerels (Bq), or disintegrations per minute.
Radioactive Waste	Any type of waste that contains radioactivity, either intrinsically or through contamination with radioactive material. There are three classes of radioactive waste (A, B, and C), based on the amount of radioactivity present.
Radiological Incident	An incident involving the release or potential release of radionuclides, including such releases from nuclear facilities; radioactive materials being transported; radioactive materials in space vehicles affecting the United States; foreign, unknown, or unlicensed material; nuclear weapons; and deliberate attacks involving nuclear/radiological facilities, or materials, including RDDs and improvised nuclear devices that have actual, potential, or perceived consequences to the United States. This guidance has focused on a radioactive incident resulting from an RDD.
Radiological Survey	A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.
Radiological Worker	An individual who is uniquely qualified to work with radioactive materials and enter radiological areas. A radiological worker receives training to meet state and federal regulations and is subject to evaluation of dose exposure to demonstrate that annual TEDE limits are not exceeded.
RCRA Hazardous Waste	A national regulatory designation for certain wastes under the RCRA. Some wastes are given this designation because they are specifically listed on one of four RCRA hazardous waste lists. Other wastes receive this designation because they exhibit at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity.
RDD	The combination of radioactive material and the means (whether active or passive) to disperse the material with malicious intent; however, fission reactions do not occur in the RDD or its dispersed material.

Term	Definition
Recovery	Those capabilities necessary to assist communities affected by a disaster to recover effectively, including, but not limited to, rebuilding infrastructure systems; providing adequate interim and long-term housing for survivors; restoring health, social, and community services; promoting economic development; and restoring natural and cultural resources.
Release	The term release is used in two ways: 1) an environmental release or 2) release from regulatory control. These meanings are typically discernable from context: Environmental release is the discharge of contaminants into the environment. Specifically, CERCLA section 101(22) defines "release" as any "...spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing any hazardous substance or pollutant or contaminant)". See Radioactive Incident. Release of items, property, or land from regulatory control means release from a level of regulatory control with respect to radioactive contamination. Note that release from regulatory control includes de minimis quantities of radioactive materials that are below regulated amounts and transition to a lesser level of control (e.g., release with restrictions).
Remediation	The actual construction or implementation of selected technologies to treat, stabilize, contain, or remove contaminated media in accordance with planned recovery actions.
Remediation Zones	Remediation zones are specific areas within the Contaminated Area that will require decontamination and exposure reduction activities, usually with the intent of reopening them for future use. Initially, remediation zones should be areas that are determined to have similar (1) land-use and (2) levels of contamination. Designating areas into zones with similar characteristics can break the problem down into more manageable pieces, facilitate the prioritization of areas for remediation, and potentially ease the logistical and planning burden to conduct the cleanup itself.
Restoration	The repair of buildings or CI in order to bring them back to a state where they can function normally. This includes, for example, repairing blast damage to buildings from an explosive RDD or fixing damaged cell tower equipment to restore cell service in impacted areas.
Radiation Health and Safety Officer (RHSO)	The authority and responsibility of a Radiation Health and Safety Officer is for the radiation protection program established during the early phase of a response. They are responsible for ensuring that radiation safety activities are being performed in accordance with approved procedures and regulatory requirements.
Screening	The process of rapidly identifying individuals potentially contaminated with radionuclides or exposed to external radiation.

Term	Definition
Secondary Device	An additional device emplaced to target first responders, other individuals, or infrastructure before, during or after a response. May or may not include radioactive material.
Shelter-in-Place Zone	<p>The extent of an area defined by the UC or public health official to protect the public from an environmental radiation hazard.</p> <p>The initial shelter-in-place zone surrounds the detonation point out to 500 meters and 2 kilometers downwind.</p>
Solid, Nonhazardous Waste	<p>Waste from homes, institutions, and commercial sources consisting of everyday items such as product packaging, grass clippings, furniture, clothing, bottles and cans, food scraps, newspapers, appliances, consumer electronics, and batteries. Excluded from this category are municipal wastewater treatment sludges, industrial process wastes, automobile bodies, combustion ash, and construction and demolition debris. (From https://www.epa.gov/report-environment/wastes#:~:text=Many%20different%20types%20of%20waste,fo ssil%20fuel%20combustion%20waste%2C%20and.)</p>
Stabilization	Temporary binding of particulate contamination to minimize migration and resuspension, providing reduction in both surface dose rate and inhalation risk to workers within the first 48-72 hours.
Sustainment	The provision for logistics, financial management, personnel services, and health service support necessary to maintain operations until successful mission completion (i.e., remediation of contaminated areas and reoccupation).
Temporary Storage Area	Location for the storage of waste before final disposition of the waste. These areas for storing waste, even temporarily, must meet local, state, and federal regulations, requires permitting, and requires regular inspection for the adequacy of the storage area for containment of waste.
Time, Distance, and Shielding	The three main principles to assist with limiting external, whole-body radiation exposure (see Focus Area 2 for more detail)
Trusted Source	These are regular people who are trusted by their community and can serve as nodes for dissemination of information to the public.
Unrestricted Release	Release of a <i>site</i> from regulatory control without requirements for future radiological restrictions. Also known as unrestricted use.
Warm Zone	The warm zone is a transition area between contaminated areas and uncontaminated areas where responders don and doff protective gear and decontamination activities take place.

Term	Definition
Whole Community	A focus on enabling the participation of a wider range of players from the private and nonprofit sectors, including NGOs and the public, in conjunction with the participation of federal, state, and local governmental partners to foster better coordination and working relationships. This term also highlights the inclusion of people with disabilities and others with access and functional needs, older adults, families, youth/children, and people with limited English proficiency.

4176

Annex B: Critical Information and Key Data Needs by Strategy

4177

4178 **Table 28: Strategy 1 - Characterize, Map, and Model**

Information Objective	Significance
Radionuclide(s) present and their location	Allows for the determination of the type(s) of radiation, type of equipment needed to detect the radiation, maps of the incident, and energies of the emitted radiation and associated hazards.
Physical and chemical properties of the material distributed	Characteristics such as the particle size or solubility will inform personal protective equipment (PPE) decisions, cleanup techniques, contamination spread mitigation, and many other aspects of the response and recovery.
Primary (e.g., ballistic debris) and secondary (e.g., residual radioactivity/contamination) sources	Identification of RDD ballistic debris can inform the law enforcement investigation as well as the dose reconstruction for emergency responders.
Responder Data	Individual responder exposure/dosimetry data will support dose assessment and determine the need for follow-up medical monitoring/intervention.
Radiological Survey Data Sets	Key data to support data quality objectives, mapping, and use of information for hazard characterization and decision making.
Exposure pathways (See Table)	Used to determine risk to the public and responders from inhalation, ingestion, and direct exposure of radioactive materials.
Categories of people for exposure pathway, dose assessment, and risk communication purposes (See Table 8)	Identifies the members of each category (remediation workers, first responders, essential employees, and public), their level of risk/exposure, and how each group can be communicated with.
Factors to determine if gross/prompt environmental decontamination is appropriate	Considers the weather forecast, environmental factors (e.g., runoff, topography), and radionuclide properties to determine if gross/prompt decontamination is appropriate.

4179

4180 **Strategy 2 – Communicate**

Information Objective	Significance
Technical information and data from other focus areas	Data needs and critical information from other focus areas will be the main driver for messaging (e.g., shelter-in-place orders) and outreach efforts (e.g., hosting public meetings to discuss remediation priorities) throughout all phases of response and recovery.
Roster of trusted sources in the community	Trusted sources will play an important role in message development, amplification, and community engagement. Identifying the trusted sources within a community and the means to reach them will facilitate their engagement in incident response and recovery.

4181 **Table 29: Strategy 3 – Monitor and Assist**

Information Objective	Significance
Radiation exposure thresholds requiring evacuation	Evacuation should be conducted in a planned, orderly, phased approach based on risk to the population in the contaminated area. This data and EPA PAGs can be used to establish evacuation zones.
Other life-safety hazards in the contaminated area	Non-radiological hazards may exceed hazards from radioactive contamination and must be considered in determining priorities for evacuation.
Geographic information required to determine evacuation routes	Geographic information such as highways, waterways, access to public transportation, etc. inform determination of evacuation routes.
Demographic and environmental information required to determine evacuation routes	Population and type of individuals within the contaminated area: residents, workers, visitors, those with special needs (e.g., medical, language, mobility), etc.; population density; type of buildings (e.g., office, commercial, residential); and environmental conditions (e.g., temperature, wind velocity and direction, humidity) are important factors in determining evacuation zones and priorities for evacuation.
Available transportation resources for evacuation	The population within the contaminated area must be given accurate and timely information and instructions on how to evacuate. This may include mass transit, POVs, and other transportation resources.
Available personnel and resources for checkpoints, canvassing evacuated zones, conducting transportation of evacuees, providing emergency services (medical, law enforcement, fire)	Conducting a phased evacuation is an effort that requires the support of multiple personnel resources. Personnel resource limitations must be considered in conducting the phased evacuation.

Information Objective	Significance
Locations for CRCs and shelters	<p>There are many considerations for picking CRC and shelter locations during an RDD incident. Some include:</p> <ul style="list-style-type: none"> ▪ Pre-existing shelter agreements or locations identified as emergency service points (such as point of dispensing locations) that could help stand up a CRC or shelter more quickly. ▪ Locations of egress routes and ease of access following an incident. ▪ Whether radiological characterization data (see Focus Area 1) indicates the location is in a low-background area. ▪ Length of time needed for services. RDD incidents may require longer sheltering times than other types of incidents.
Calculations of exposed population’s radiation exposure	<p>Helps determine if radiation exposure levels warrant additional medical services. Consider:</p> <ul style="list-style-type: none"> ▪ Locations and times of exposure in the Contaminated Area. ▪ Records on contamination levels when screened. ▪ Dosimetry data if available.
Quality of available water and food	<p>May involve testing tap water, wastewater, food, and agricultural products for contamination levels. To test food, locations of all meat, dairy, food storage, greenhouses/gardens/farmland (including individual/neighborhood ones) in the jurisdiction need to be identified. Appropriate actions after determining safety could include communications or removing products from commerce.</p>

4182 **Table 30: Strategy 4 – Restore the Environment**

Information Objective	Significance
Safety and security hazards and other issues in the contaminated area	<p>Addressing non-radiological hazards and other issues such as damaged infrastructure, criminal activity within the affected area, etc., may require expedited remediation as soon as it is safe for personnel to enter the contaminated area.</p>
Building/infrastructure function, occupancy, and maintenance information with priority given to critical infrastructure and mitigating further damage and impacts resulting from functional disruption of facility/system	<p>Helps prioritize restoration and sustainment of essential infrastructure, protect building contents, and monitor critical building functions such as HVAC systems, security, and fire alarm systems.</p>

Information Objective	Significance
Cleanup levels for remediation	Cleanup levels are agreed upon by multiple parties and must address public health objectives and the technical, economic, and social feasibility of the available decontamination methods that will meet expectations for the residual radiation after remediation. Agreement on cleanup levels may require revisions as parties review and ultimately come to a consensus on the levels for remediation.
Remediation zone boundaries	As part of the Optimization Process, remediation zones are established that have similar land-use and levels of contamination. Remediation zones have similar characteristics, facilitate the prioritization of areas for remediation, and potentially ease the logistical and planning burden to conduct the cleanup itself. Consider geographic, demographic, and environmental characteristics in determining zone classifications.
Temporary waste/debris staging areas	In the early phase, waste and debris will be moved to temporary locations for staging and storage. This information will establish initial locations, allowing for segregation of waste types, securing the material, and managing spread of contamination from the waste and debris. Early efforts will help minimize waste volumes and recovery costs.
Estimates of the volume of waste for remediation and recovery	The volume of waste addressed/generated via remediation activities will drive plans for staging areas through final disposition. EPA's WEST provides planners with a process to estimate the quantity and characteristics of waste from an incident and decontamination activities for final disposition of waste by type of waste (e.g., non-hazardous solid waste vs. LLRW). Outcome of waste volume by waste type is important in exploring options to achieve waste management goals.
Options for final disposal plans	Final disposition options range from on-site (within the contaminated area) disposal to the use of off-site waste facilities. In planning for final disposal locations, consider types of waste and associated volumes, options for disposal sites, and feasibility of transportation to the final disposal location.

4183 **Table 31: Strategy 5 – Reopen and Recover**

Information Objective	Significance
Pre-incident property records such as land/facility use, zoning, real estate value, and development plans	Information will help establish a baseline for the affected property, facilities, and land, and inform re-use and reopening decisions, especially regarding modifications to permitted use due to residual contamination.

Information Objective	Significance
Sustainment data about the integrity/damage of buildings and facilities, including the structural and aesthetic conditions of areas in the remediation zone	Information will inform the level and scope of repairs needed before reopening.
Residual contamination measurements of the property, facilities, and land in the remediation zone	Information directly informs reopening and re-use decisions. If the cleanup level for a facility, property, or land area is above that permissible for unrestricted public use, then an alternative land-use with restrictions will need to be identified, agreed upon, and implemented.
Habitability assessment data for each property collected as repairs continue	Habitability assessment results will directly influence whether a property is safe to be reoccupied and informs the reopening schedule.
Demographic characteristics, critical infrastructure, contiguous neighborhoods, and buildings in the remediated areas	Information will help prioritize reopening to address the needs of vulnerable populations. It will also help expedite the reopening of areas with collocated critical infrastructure as well as contiguous neighborhoods.
Availability of building materials and skilled workers	Information will help inform the schedule for repairs and habitability assessments.
Current zoning plans, building/facility demolition, debris removal, construction, land/property acquisition, and redevelopment plans	Information will inform the scope and level of recovery efforts needed for the affected community.
Information about major recovery projects such as housing and infrastructure rebuilding needs	Information will help prioritize recovery resources and focus the planning efforts for long-term, resource-intensive projects.
Baseline economic data to characterize pre-incident economic indicators and metrics	Information will help establish the pre-incident baseline about the community's economic wellbeing, which will in turn help quantify recovery success metrics (e.g., % of remediated areas has been reopened, number of new jobs and new businesses since reopening).
Availability of federal, state, and local government assistance programs, and applicable nonprofit and insurance programs	Information will identify the available resources that can be used for recovery and will also inform the recovery timeline.

Information Objective	Significance
<p>Information about properties and parcels, building/facility demolition/abatement, debris removal, construction, and redevelopment planning and permits.</p>	<p>Information will be needed to establish ownership and identify vested interests among affected properties including businesses and private residences. Aligning recovery efforts will require ongoing assessment of how to efficiently apply recovery resources to targeted areas of need, which may include both public and private efforts and stakeholders such as commercial districts, HOAs, and individual homeowners.</p>
<p>Survey of government agencies and NGOs engaged in recovery activities and providing recovery support to survivors</p>	<p>Information likely will include entities such as nonprofit grantmaking foundations, VOAD agencies, government agencies which are providing direct or indirect health and social services, as well as other entities engaged in supporting recovery efforts. Some of these agencies may be local/regional, while others may be national-level organizations.</p>
<p>Economic data and economic development plans</p>	<p>Understanding the projected long-term economic development goals of the affected community, such as those outlined in the Comprehensive Economic Development Strategy (CEDS), will provide recovery planners with an understanding of how the economic trajectory of the affected community(ies) may be impacted by the RDD event.</p>
<p>Financial assistance data including federal, state, and local government assistance programs, and applicable nonprofit and insurance programs</p>	<p>Information is necessary to support disaster case management efforts. Establishing information sharing agreements among recovery stakeholders is crucial to the long-term success of disaster case management activities because it mitigates duplication of effort and duplication of benefits and enhances survivor access to the full spectrum of available recovery support programs and avenues of assistance.</p>

4184 **Annex C: Radiological** 4185 **Communications Tools**

4186 **Training Resources**

4187 **ESSENTIALS OF ALERTS, WARNINGS, AND NOTIFICATIONS (CISA, 2020)**

4188 [https://www.cisa.gov/sites/default/files/publications/CISA%20Essentials%20of%20AWNs_4.27.20](https://www.cisa.gov/sites/default/files/publications/CISA%20Essentials%20of%20AWNs_4.27.20%20-%20FINAL%20%28508c%29.pdf)
4189 [%20-%20FINAL%20%28508c%29.pdf](https://www.cisa.gov/sites/default/files/publications/CISA%20Essentials%20of%20AWNs_4.27.20-%20-%20FINAL%20%28508c%29.pdf)

4190 Guide for using different types of emergency communications platforms, including information
4191 regarding when certain platforms are more appropriate and technical restrictions on message length
4192 and type.

4193 **MYTHS OF RADIATION: COMMUNICATING IN RADIATION EMERGENCIES (CDC, 2022)**

4194 <https://www.cdc.gov/nceh/radiation/emergencies/radiationmyths.htm>

4195 Series of training videos that introduce participants to some common myths surrounding radiation
4196 and identifies communications strategies to combat these and other myths. The training uses
4197 Person-On-The-Street interviews to identify the myths and features a discussion between risk
4198 communication and radiation subject matter experts to set the record straight.

4199 **PSYCHOLOGICAL FIRST AID IN RADIATION DISASTERS (CDC, 2022)**

4200 <https://www.ornl.gov/rsb/pfaidd/>

4201 Online audio and text training course that discusses first-hand experience from radiation
4202 emergencies and corresponding psychological mental health impacts. While primarily focused on
4203 psychological first aid in the immediate aftermath of an incident, the issues of fear of radiation and
4204 social stigma of victims will continue to impact communication needs during intermediate and later
4205 phases.

4206 **RADIATION RISK COMMUNICATION FOR PUBLIC HEALTH (WD4239) (CDC, 2021)**

4207 <https://www.cdc.gov/nceh/radiation/emergencies/cerc.htm>

4208 Online training videos that highlight basic radiation concepts. Also provides several communication
4209 resources and lessons learned that can help professionals involved in emergency response prepare
4210 for and deliver clear messages during a radiological or nuclear disaster. It also highlights several
4211 myths and misunderstandings related to radiation exposure and contamination.

4212 **Communication Planning Guides and Toolkits**

4213 **“SECTION 7.0 COMMUNICATING RADIATION RISK TO SHELTER STAFF AND RESIDENTS” IN**
4214 **A GUIDE TO OPERATING PUBLIC SHELTERS IN A RADIATION EMERGENCY (CDC, 2015)**

4215 <https://emergency.cdc.gov/radiation/pdf/operating-public-shelters.pdf>

4216 Section 7.0 details communication needs specific to operating a public shelter during a radiation
4217 emergency, including topics likely to arise (7.3) and communication strategies and tools (section
4218 7.4). Additionally, section 7.5 includes links to general guidance for communicating for any type of
4219 radiation emergency as well as documents tailored to nuclear detonation and power plant response.

4220 **COMMUNICATING DURING AND AFTER A NUCLEAR POWER PLANT INCIDENT (FEMA, 2013)**

4221 [https://www.fema.gov/sites/default/files/documents/fema_nuclear-power-plant-](https://www.fema.gov/sites/default/files/documents/fema_nuclear-power-plant-incident_communicating-during-after_june-2013.pdf)
4222 [incident_communicating-during-after_june-2013.pdf](https://www.fema.gov/sites/default/files/documents/fema_nuclear-power-plant-incident_communicating-during-after_june-2013.pdf)

4223 This guide is designed for use in the aftermath of a nuclear power plant incident. While several
4224 topics specific to nuclear power plan regulations and insurance laws are not relevant to RDD events,
4225 this document provides a useful supplement to the FEMA IND *Communicating in the Immediate*
4226 *Aftermath* guide, because the level of radiation released and structural damage in an RDD incident
4227 is more likely to resemble a nuclear power plant incident rather than an IND. For example, this
4228 guidance contains more questions and answers in the context of evacuation instructions.

4229 **COMMUNICATING RADIATION RISKS: COMMUNICATIONS FOR EMERGENCY RESPONDERS**
4230 **(EPA, 2022)**

4231 https://www.epa.gov/system/files/documents/2022-02/comm_rad_risks_11222.pdf

4232 A comprehensive guide for communications during a radiation emergency, including FAQs along with
4233 plain language answers designed for simplicity of understanding during a crisis.

4234 **IMPROVISED NUCLEAR DEVICE RESPONSE AND RECOVERY – COMMUNICATING IN THE**
4235 **IMMEDIATE AFTERMATH (FEMA, 2013)**

4236 [https://www.fema.gov/sites/default/files/documents/fema_improvised-nuclear-](https://www.fema.gov/sites/default/files/documents/fema_improvised-nuclear-device_communicating-aftermath_june-2013.pdf)
4237 [device_communicating-aftermath_june-2013.pdf](https://www.fema.gov/sites/default/files/documents/fema_improvised-nuclear-device_communicating-aftermath_june-2013.pdf)

4238 Designed for use in the immediate aftermath of an improvised nuclear device explosion but contains
4239 FAQs applicable to RDD response and recovery. One of the key distinctions between an RDD incident
4240 and an IND incident is that for the latter the likelihood of extensive spread and dispersal of
4241 radioactive material following the incident is much greater. Messaging from this document regarding
4242 specifics about the spread of contamination will need to be adapted accordingly.

4243 **RADRESPONDER'S PUBLIC RESOURCE DOCUMENTS**

4244 <https://www.radresponder.net/#resources/documents/index>

4245 Serves as a one-stop-shop for many of the same communication tools that are showcased in this
4246 annex (e.g., messages, infographics, Q+As, etc.)

4247 **Protective Action Resources**

4248 **PROTECTIVE ACTION AREA MAP TEMPLATES. EPA-420 (EPA, 2017)**

4249 <https://www.epa.gov/sites/default/files/2017->

4250 [11/protective_action_area_map_templates_11202017_final_1.docx](https://www.epa.gov/sites/default/files/2017-11/protective_action_area_map_templates_11202017_final_1.docx).

4251 Word document (.docx format) with customizable templates for providing protective action guidance
4252 quickly to a population in a specific geographical area during a radiological or nuclear emergency.
4253 Protective actions include evacuation areas, shelter-in-place, and food and drinking water guidance.

4254 **PROTECTIVE ACTION QUESTION & ANSWERS FOR RADIOLOGICAL & NUCLEAR**
4255 **EMERGENCIES: A COMPANION DOCUMENT TO THE U.S. ENVIRONMENTAL PROTECTION**
4256 **AGENCY PROTECTIVE ACTION GUIDE (PAG) MANUAL (EPA, 2022)**

4257 https://www.epa.gov/system/files/documents/2022-02/pags_comm_tool_2022.pdf.

4258 Provides pre-scripted radiation emergency public safety messages intended to help emergency
4259 planners prepare public communications prior to and during a radiological emergency.

4260 **Radiation Education Materials**

4261 **RADIATION EMERGENCIES RESOURCE LIBRARY (CDC, 2022)**

4262 <https://www.cdc.gov/nceh/radiation/emergencies/index.htm>

4263 Provides a wide array of information for the public and for professionals, including infographics,
4264 educational videos, and a resource library.

4265

Annex D: Remediation Techniques and Technologies

4266

4267 Several terms are used to refer to remediation of radiologically contaminated areas. This annex
4268 provides an overview of the key concepts, methods, and techniques for remediation of environments
4269 contaminated with radiological materials due to an incident such as an RDD detonation. The phrase
4270 “Deactivation, Decommission, Decontamination, and Demolition” (or “D4”) is used by the
4271 radiological remediation sector responsible for closing nuclear facilities (e.g., a nuclear power plant).
4272 However, the techniques and technologies for nuclear facilities, which are usually confined and
4273 controlled, are not the same as a wide urban or rural area, as may occur for an RDD response and
4274 recovery. In the RDD case, the focus is on “decontamination and physical removal.”
4275 “Decontamination” refers to activities that remove and/or destroy contamination from an
4276 undesirable place, such as a vehicle, or building. “Physical removal” deals with removing
4277 contaminated portions of objects, like roofing materials from buildings whereas “demolition” involves
4278 tearing-down buildings and other structures so they can be removed and stored as contaminated
4279 waste. Demolition is generally done in situations when decontamination is not feasible and/or the
4280 structural integrity has been damaged beyond repair due to the blast effects stemming from and
4281 RDD explosive detonation.

4282 A combination of approaches will be used to achieve overall remediation of contaminated areas
4283 following an RDD incident. This annex is meant to supplement a planner’s understanding of the
4284 factors that must be considered by experts and stakeholders when planning and executing the
4285 activities described in this *RDD Response and Recovery Guidance*, particularly when working with
4286 remediation contractors to develop a remediation plan for contaminated areas. Early
4287 decontamination efforts will rely on simple, rapid techniques (e.g., hosing down areas with water)
4288 that attempt to minimize exposures on the scene and to remove the contamination before it has
4289 time to sink into the porous structure of some materials. Later phase decontamination techniques
4290 may involve more complex technologies that require multiple applications. The background
4291 information in this annex is most relevant for the following focus areas:

- 4292
- 4293 ■ **Focus Area 2: Implement Radiation Exposure Mitigation:** Some decontamination techniques may
4294 be used during the early and intermediate phases to reduce the risk of unnecessary or
4295 dangerous exposure to emergency responders operating on the scene and the public as they
evacuate.

 - 4296 ■ **Focus Area 7: Remediate:** The technical feasibility, cost, effectiveness, and environmental impact
4297 of various remediation techniques influences decision-making during the optimization process.

 - 4298 ■ **Focus Area 8: Manage and Dispose of Waste:** The volume, type, and form of waste generated is
4299 directly dependent upon the remediation techniques and cleanup levels that are chosen.

4300 The decontamination techniques discussed in this section are focused on contaminated buildings
4301 and/or environments and are not appropriate for decontamination of people, pets, decedents, or
4302 personal belongings. Therefore, information in this annex is not relevant to Focus Area 5: Screen and
4303 Decontaminate.



Recommended Resources:

4305 Additional references and tools discuss decontamination and physical removal in more detail.
4306 **Important Disclaimer:** Many of the resources provided below are written for or about the
4307 decommissioning industrial sites (e.g., commercial nuclear power facilities). Not all procedures,
4308 techniques, or technologies discussed will be appropriate for remediating an urban area after
4309 an RDD detonation or other uncontrolled release of radioactive material. However, these
4310 resources can serve as a starting point for planners to better understand the menu of options
4311 that might be considered by remediation experts when they develop a remediation plan.

4312 ▪ A more in-depth overview of decontamination techniques and technologies is provided in
4313 EPAs Radiological Recovery Logistics tool (RRLT, 2022) or through the EPA’s Radiological
4314 Decontamination Query Tool. RRLT is available at:
4315 [https://www.epa.gov/sites/default/files/2020-](https://www.epa.gov/sites/default/files/2020-02/documents/kaminski_radiological_recovery_logistics_tool_epa_decon_2019_posterv2.pdf)
4316 [02/documents/kaminski_radiological_recovery_logistics_tool_epa_decon_2019_posterv2](https://www.epa.gov/sites/default/files/2020-02/documents/kaminski_radiological_recovery_logistics_tool_epa_decon_2019_posterv2.pdf)
4317 [.pdf](https://www.epa.gov/sites/default/files/2020-02/documents/kaminski_radiological_recovery_logistics_tool_epa_decon_2019_posterv2.pdf) . And the Radiological Decontamination Query Tool is available at:
4318 [https://www.epa.gov/emergency-response-research/radiological-decontamination-query-](https://www.epa.gov/emergency-response-research/radiological-decontamination-query-tool)
4319 [tool](https://www.epa.gov/emergency-response-research/radiological-decontamination-query-tool) . .

4320 ▪ Understanding the options, cost, and overall effort to address the waste that will be
4321 generated through remediation. EPA’s Waste Estimation Support Tool (WEST) is a planning
4322 tool that can help guide the considerations key to successful remediation:
4323 [https://www.epa.gov/emergency-response-research/waste-estimation-support-tool-west.](https://www.epa.gov/emergency-response-research/waste-estimation-support-tool-west)

4324 Decontamination Techniques and Technologies

4325 Techniques and technologies for decontamination of contaminated structures and environments
4326 structures fall into two major categories: chemical solutions and physical techniques. Although, as
4327 described below, specific approaches often employ techniques from both categories.

4328 CHEMICAL SOLUTIONS

4329 Chemical decontamination technologies use specific chemicals or solutions (e.g., detergent, acid,
4330 water) to wash or dissolve the radiological contaminants from the surface or, if the radiological
4331 contaminant is embedded in the surface, to dissolve the surface itself to remove the radioactive
4332 material. Advantages of using chemical solution techniques include the ability to decontaminate less
4333 accessible areas and provide a more time-sensitive option than physical removal. When selecting the
4334 most appropriate chemical decontamination method, careful consideration should be given to

4335 characteristics of the contaminated area and the interaction between the surface properties,
4336 contaminants, and chemical solutions (this will require expert knowledge). Chemical solutions can be
4337 tailored to target specific radionuclides and are available in different forms including liquids, foams,
4338 gels, and pastes. However, chemical solutions may produce large volumes of liquid waste and
4339 depending on the chemicals used, may also result in mixed wastes. Chemical decontamination
4340 technologies include:

- 4341 ▪ **Chemical Extracts:** This process involves applying a coating to the surface that adheres to or
4342 dissolves the radioactive contaminants bound to the surface material. Extractants are sprayed or
4343 manually applied to the surface or scrubbed into porous material to remove surface
4344 contamination; and then after a treatment period, the extractant is rinsed or vacuumed away,
4345 along with the radioactive contaminants. Many different chemicals can be used as extractants
4346 and are selected based on the radionuclide and surface materials involved. Extractants may
4347 require collection of solid and liquid waste in a manner that contains further contamination.
- 4348 ▪ **Peelable Coatings:** Peelable coatings are chemical extractants applied as a liquid. After the
4349 coating dries, the solid layer is peeled away along with the radioactive contaminants. Peelable
4350 coatings limit contaminated waste to the coating itself.

4351 **PHYSICAL TECHNIQUES**

4352 Physical techniques, which also are referred to as mechanical techniques, rely on vacuuming,
4353 sweeping, scrubbing, or abrading a surface to remove radiological contamination. Radionuclides may
4354 bind with the surfaces of objects and structures, requiring physically removing of the surface down to
4355 a point where the radiation is removed or significantly reduced. These include “wet” or “dry”
4356 technologies:

- 4357 ▪ **Pressure washing:** This technique uses a high-pressure water spray to remove radiological
4358 contamination and other materials (e.g., paint and dirt) from the surface of buildings, structures,
4359 or other large objects. Pressure washing techniques require additional planning to account for
4360 efficient use of water, the chemical or physical properties of the contaminant, and collection of
4361 contaminated water. Technologies for pressure washing should be evaluated based on the
4362 surface and material to be decontaminated; an appropriate pressure should be selected to
4363 remove the contamination without destroying the material. Evaluation of pressure washers
4364 should also consider containment of the spent wash water for further treatment. Conventional
4365 pressure washers, as well as devices that can generate very high pressure (5,000 to 20,000 psi;
4366 also called “hydrolasing”) are available. Chemical additives (e.g., detergents, acids) may improve
4367 the decontamination effectiveness and may be used for surface preparation.
- 4368 ▪ **Surface Scarification:** Devices that cut or chip away outer layers of walls or floors, leaving behind
4369 an uncontaminated but scarred surface. Devices include shavers and scabblers, which can be
4370 adjusted to set the depth of material removed. Dust and material are captured with exhaust
4371 hoses connected to HEPA air filters to minimize the spread of contamination and protect workers
4372 from dust inhalation hazards.

4373 ▪ **Surface Blasting:** This technique is similar to pressure washing but instead involves physical
4374 abrasion of the surface of walls or floors by directing a stream of abrasive material at the surface
4375 using pressurized air or water. Abrasives include grit, steel shot, glass beads, or chemical pellets
4376 (sodium bicarbonate or dry ice/carbon dioxide). Depending on the abrasive material involved,
4377 surface blasting can be destructive or nondestructive. Exhaust hoses connected to air filters are
4378 needed for collection of dust and abrasives. Wet surface blasting would require collection and
4379 treatment of the water.

4380 The use of chemical or physical decontamination technologies should include plans for addressing
4381 worker health and safety as well as managing the waste generated. Considerations of worker health
4382 and safety may exclude some technologies from further consideration (e.g., working in confined
4383 spaces or unstable structures).

4384 **Demolition Techniques and Technologies**

4385 Demolition is the removal of building structures, slabs, or foundations. It presents an alternative
4386 technique to remediate a radiologically contaminated area should decontamination not be
4387 appropriate or technically feasible. Careful planning should be done to determine if the area or
4388 structure will be completely demolished, or if uncontaminated equipment or sections can be
4389 deconstructed, segregated, and disposed of separately or potentially reused. Criteria should be
4390 established for fixing and leaving contaminated material/equipment in place or removing prior to
4391 demolition – small, contaminated items may be better to remove beforehand. This assessment will
4392 benefit waste minimization efforts significantly, to reduce overall disposal volume, weight, and costs.

4393 Demolition of radiologically contaminated structures can present unique challenges, such as
4394 generation of large, bulk contaminated debris or the need for additional techniques to mitigate the
4395 spread of contamination in the context of open-air demolition⁸⁴ (e.g., misting nozzles, application of
4396 fixatives, plastic wrap). The criteria for open air demolition (as opposed to demolition utilizing tents or
4397 enclosures), is based upon the potential offsite dose estimates from airborne radioactive
4398 contaminants and selecting a process that keeps the exposure as low as reasonably achievable.
4399 Other potential hazards including asbestos, lead, mercury, PCBs, pressurized tanks, etc. may exist.
4400 Additionally, items may need to be removed from the structure as part of the pre-demolition hazard
4401 assessment and planning phases.

4402 Demolition is a technique that can be successfully applied to radioactively contaminated structures.
4403 With proper planning, the demolition team can determine the most appropriate demolition method
4404 depending on the size of structure(s), duration, location, and technologies available. Methods for
4405 demolition may involve removal activities within a building or removal of the entire building.
4406 Technologies for demolition are selected with the site-specific conditions mentioned above and are

⁸⁴ Many references discuss considerations for open air demolition of radiologically contaminated facilities. For example: E R. Lloyd (2007) "Open Air Demolition of Facilities Highly Contaminated with Plutonium." Available online at: <https://www.osti.gov/servlets/purl/908296>.

4407 best performed with qualified and workforces with experience in remediating radiological demolition
4408 at other sites within the U.S. (e.g., legacy waste sites or decommissioned nuclear facilities).

4409 When planning demolition of radioactively contaminated structures, the following should be taken
4410 into consideration:

- 4411 ▪ Define the “end state” of demolition, with consideration for culturally or historically sensitive
4412 areas and critical infrastructure.
- 4413 ▪ Determine appropriate radiological control boundaries (areas where radiological contamination
4414 can be managed safely during demolition and separate from areas where the public are allowed)
4415 and plan for radiological monitoring before/after demolition.
- 4416 ▪ Implement contamination control measures such as fixatives or dust suppression. Monitor
4417 contamination during the demolition.
- 4418 ▪ Manage demolition materials and waste disposal.

4419  Recommended Resources:

Important Disclaimer: Similar to the resources recommended above, many of the resources provided below are written for or about the decommissioning industrial sites (e.g., commercial nuclear power facilities). Not all procedures, techniques, or technologies discussed will be appropriate for remediating an urban area after an RDD detonation or other uncontrolled release of radioactive material.

- 4425 ▪ *EPA’s Technology Reference Guide for Radioactively Contaminated Media*. Provides a
4426 summary of information available for technologies demonstrated to be effective for
4427 treatment of radioactively contaminated media. Available online at:
4428 <https://www.epa.gov/sites/default/files/2015-05/documents/402-r-06-003.pdf>
- 4429 ▪ EPA’s Technical Report for the Demonstration of Wide Area Radiological Decontamination
4430 and Mitigation Technologies for Building Structures and Vehicles. Provides a summary of
4431 five wide-area radiological decontamination technologies (including strippable coatings,
4432 gels, and chemical foam technologies) demonstrated on an urban building. **Available**
4433 **Online at:**
4434 https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=529008&Lab=NH
4435 [SRC](#)
- 4436 ▪ *EPA’s Waste Management Tool Kit*. Decision Support Tools for Waste Management
4437 includes an extensive list of tools, identifies a location to download software, and provides
4438 further information on the tool kit’s purpose and applicability. Includes WMP, I-WASTE,
4439 WEST, and Waste Storage and Staging Tool. Available online at:
4440 <https://www.epa.gov/emergency-response-research/decision-support-tools-waste-management>

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- *Brookhaven National Laboratory, Decontamination Technologies Task 3: Urban Remediation and Response Project*. Provides an overview of the decontamination technologies that could be used to remediate areas and/or reduce waste disposal. This document was developed with RDD impacts in-mind. Available online at: <https://www.bnl.gov/isd/documents/45491.pdf>
 - *Interstate Technology & Regulatory Council (ITRC), Decontamination and Decommissioning of Radiologically Contaminated Facilities*. Overview of the process, regulatory framework, costs, technologies, and health and safety considerations. Provides case studies of past decontamination efforts. Available online at: <https://connect.itrcweb.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=2a9bed64-15d2-4c53-8f2d-1d5100e5fc89>
 - *DOE Standard Operating Procedure for Demolition of Facilities in Area IV at the Santa Susana Field Laboratory*. A description of the process and procedure that would be used to demolish the DOE structures in an area of the Santa Susana Field Laboratory and manage disposal of materials generated by the removal of these structures.
 - *WM Symposia*. A non-profit organization that annually sponsors an international conference on education and opportunity in radwaste management. Publishes conference proceedings, including the latest available techniques and technologies on decommissioning. Available online at: <https://www.wmsym.org/>

4460 **Annex E: Radiological Software** 4461 **Tools**

4462 **Software Tools for Radiological Recovery**

4463 **CBRNResponder or RadResponder | Focus Area 1 | Collection/Mapping Tool**

- 4464 ▪ CBRN Responder: <https://www.cbrnresponder.net/>
- 4465 ▪ RadResponder link will be maintained: <https://www.radresponder.net/>
- 4466 ▪ It is a single, secure platform sponsored by FEMA for all chemical, biological, radiological, and
4467 nuclear (CBRN) incident data sharing and multi-hazard event management.
- 4468 ▪ It serves as a hub and one-stop shop for all-hazard planning, preparedness, communication, and
4469 operational tools and resources.

4470 **VSP | Focus Areas 1 & 6 | Collection/Mapping Tool**

- 4471 ▪ <https://www.pnnl.gov/projects/visual-sample-plan>
- 4472 ▪ Visual Sample Plan (VSP) has been developed by Pacific Northwest National Laboratory since
4473 1997 with support from the U.S. Department of Energy (DOE), U.S. Environmental Protection
4474 Agency, U.S. Nuclear Regulatory Commission, and other government agencies.
- 4475 ▪ Windows desktop software tool for developing statistically defensible sampling plans and
4476 performing statistical analysis.
- 4477 ▪ Designed to answer how many samples or measurements should be taken, where they should
4478 be located, and what the resulting confidence in the decision is.
- 4479 ▪ Mapping and visualization of samples and data results.
- 4480 ▪ Implements statistical methods from MARSSIM and EPA's QA/G-4 guidance.

4481 **TurboFRMAC | Focus Area 2 | Radiation Protection Tool**

- 4482 ▪ <https://nirp.sandia.gov/Software/TurboFRMAC/TurboFRMAC.aspx>
- 4483 ▪ The Federal Radiological Monitoring and Assessment Center (FRMAC) is a federal asset and
4484 interagency organization available on request by the Department of Homeland Security (DHS) to
4485 respond to nuclear and radiological incidents as described in the National Response Framework
4486 (NRF).

4487 ▪ TurboFRMAC is an analysis tool that quickly performs complex calculations to assess impacts to
4488 the public, workers, and the food supply from radiological hazards during an emergency
4489 response. It covers radiological incidents such as:

4490 ○ Radiological Dispersal Devices (RDDs)

4491 ○ Nuclear Power Plant Emergencies

4492 ○ Fuel Handling Accidents

4493 ○ Transportation Accidents

4494 ○ Nuclear Detonations

4495 **RESRAD | Focus Area 2 | Radiation Protection Tool**

4496 ▪ <https://ramp.nrc-gateway.gov/codes/resrad>

4497 ▪ Analyze potential human and biota radiation exposures from environmental contamination. It
4498 evaluates radiation exposure and associated risks using pathway analysis. RESRAD derives
4499 cleanup criteria or authorized limits for radionuclide concentrations in the contaminated source
4500 media.

4501 **RAMP | Focus Area 2 | Radiation Protection Tool**

4502 ▪ <https://ramp.nrc-gateway.gov/>

4503 ▪ RAMP = Radiation Protection Computer Code Analysis and Maintenance Program

4504 ▪ RAMP develops, maintains, improves, distributes, and provides training on NRC-sponsored
4505 radiation protection and dose assessment codes. These codes calculate dose for environmental
4506 assessment, nuclear power plant licensing, emergency response, atmospheric assessment, and
4507 other dose assessment scenarios. The research mission is to develop technical bases to support
4508 regulatory decisions. A goal to make sure the code reflects International Regulations and
4509 Guidance documents.

4510 **REMM | Focus Areas 2 & 5 | Interactive Clinical Tool**

4511 ▪ <https://remm.hhs.gov/>

4512 ▪ <https://remm.hhs.gov/interactivetools.htm>

4513 ▪ REMM = Radiation Emergency Medical Management

4514 ▪ Provide just-in-time, evidence-based, usable information with sufficient background and context
4515 to make complex issues understandable to those without formal radiation medicine expertise.

- 4516 ■ Includes resources, tools, and a REMM S/W application for smartphones.

4517 **CRC Drill Toolkit, CRC-SimPLER, & ‘This is a T.E.S.T. CRC’ | Focus Area 5 |**
4518 **Community Reception Center Tool**

- 4519 ■ CRC Drill Toolkit website: <https://www.cdc.gov/nceh/radiation/emergencies/crc/crctoolkit.htm>

- 4520 ■ CRC SimPLER website: <https://ephtracking.cdc.gov/Applications/simPler/crc/home>

- 4521 ■ ‘This is a T.E.S.T. CRC’ website:

- 4522 <https://www.cdc.gov/nceh/radiation/emergencies/training/crctest.htm>

- 4523 ■ The CRC Drill Toolkit, CRC-SimPLER, and ‘This is a T.E.S.T. CRC’ were made by the Centers for
4524 Disease Control and Prevention (CDC).

- 4525 ■ These are planning and simulation tools for setting up CRCs for radiological emergencies

- 4526 ■ Use your existing resources to identify bottlenecks and areas that could benefit from more
4527 resources

- 4528 ■ Also useful for training purposes

- 4529 ■ Information on studies of removal of radioactive contamination from various surfaces.

4530 **Radiation Decontamination Query Tool | Focus Area 7 | Remediation Tool**

- 4531 ■ <https://www.epa.gov/emergency-response-research/radiological-decontamination-query-tool>

- 4532 ■ EPA tool that provides information on studies of removal of radioactive contamination from
4533 various surfaces.

4534 **PRG Goals and Calculator | Focus Area 7 | Remediation Tool**

- 4535 ■ https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search/ (can be downloaded too)

- 4536 ■ EPA’s Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites
4537 Calculator

- 4538 ■ Recommended preliminary remediation goals (PRGs) are calculated on this website. These PRGs
4539 are for contaminated soil, water, and air.

- 4540 ■ The PRGs are risk-based, conservative screening values

4541 **Rad Decon (in RadResponder) | Focus Area 7 | Radiation Decontamination**
4542 **Tool**

- 4543 ▪ The website for the tool requires a RadResponder login for access (see
4544 <https://www.radresponder.net/#resources/tools/index>)
- 4545 ▪ The Rad Decon tool was developed by DHS S&T and the EPA.
- 4546 ▪ FEMA adopted the Rad Decon tool into the RadResponder system in January 2018.
- 4547 ▪ The Rad Decon tool is a “discussion support” tool meant to provide a common basis of
4548 information for executive decision makers and subject matter experts. The Rad Decon tool
4549 guides users through setting parameters and priorities based on the conditions of a specific
4550 radiological event to prioritize decontamination strategies. It provides a list of possible solutions
4551 based on these common reference points.
- 4552 ▪ This tool is more associated with the early phase rather than the late phase of recovery.

4553 **RRLT | Focus Area 7 | Remediation Tool**

- 4554 ▪ The website for the tool is in production at the time of this report (July 2022)
- 4555 ▪ [https://www.epa.gov/sites/default/files/2020-](https://www.epa.gov/sites/default/files/2020-02/documents/kaminski_radiological_recovery_logistics_tool_epa_decon_2019_posterv2.pdf)
4556 02/documents/kaminski_radiological_recovery_logistics_tool_epa_decon_2019_posterv2.pdf
4557 contains an overview of what the tool can do and why it is important
- 4558 ▪ RRLT = Radiological Recovery Logistics Tool
- 4559 ▪ Can be used during the response and recovery from a radiological or nuclear incident to
4560 effectively allocate appropriate commercial and public works equipment to mitigate, remove, and
4561 contain radiological contamination.

4562 **Waste Management Tool Kit | Focus Area 8 | Waste Tool**

- 4563 ▪ <https://www.epa.gov/emergency-response-research/decision-support-tools-waste-management>
- 4564 ▪ EPA’s Decision Support Tools for Waste Management includes an extensive list of tools, location
4565 to download software, with further information on the purpose and applicability
- 4566 ▪ Includes WMP, I-WASTE, WEST, and Waste Storage and Staging Tool (further information below)

4567 **WMP | Focus Area 8 | Waste Planning Tool**

- 4568 ▪ <https://wasteplan.epa.gov/>
- 4569 ▪ WMP = All Hazards Waste Management Planning

- 4570 ▪ Provided by the EPA an All-Hazards Waste Management Planning (WMP) to address the
4571 management of waste generated by all hazards, including nuclear incidents to terrorist attacks
4572 involving radiological agents

4573 **WEST | Focus Area 8 & Annex B | Waste Estimation Tool**

- 4574 ▪ <https://www.epa.gov/emergency-response-research/waste-estimation-support-tool-west>
- 4575 ▪ WEST = RDD Waste Estimation Support Tool
- 4576 ▪ To aid in estimating waste generated from remediation and cleanup activities following a
4577 radiological or biological incident. The website states that it is important for users have
4578 experience with geographic information systems (GIS), FEMA's Hazus-MH, and Microsoft Excel

4579 **I-WASTE | Focus Area 8 & Annex B | Waste Handling &, Transport**

- 4580 ▪ <https://iwaste.epa.gov/guidance>
- 4581 ▪ I-WASTE = EPA's Incident Waste Decision Support Tool
- 4582 ▪ Web based decision support tool that organizes information related to managing waste resulting
4583 from terrorist attacks and other emergencies
- 4584 ▪ To provide information for planning how to handle, transport, treat, and dispose of contaminated
4585 waste and debris.
- 4586 ▪ I-Waste includes a waste volume calculator

4587 **Waste Storage and Staging Tool | Focus Area 8 & Annex B | Waste Tool**

- 4588 ▪ Available through https://github.com/USEPA/Waste_Staging_Tool
- 4589 ▪ Used to identify potential waste staging areas and storage sites
- 4590 ○ Conducts suitability analyses to determine implicating factors
- 4591 ○ (i.e., environments to avoid) and favorable characteristics
- 4592 ○ (i.e., certain topographic features and transportation-related infrastructure)

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Annex F: Medical Resources

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Table 32: Medical Care Resources

Resource	Source	Description	Link
Disaster Medical Assistance Team (DMAT)	HHS	DMATs are staffed with medical professionals who provide expert patient care. DMAT members include advanced practice clinicians (nurse practitioners/physician assistants), physicians, registered nurses, respiratory therapists, paramedics, pharmacists, safety specialists, logistical specialists, information technologists, and communication and administrative specialists.	www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/dmat.aspx

Resource	Source	Description	Link
Emergency Radiation Medicine Response Pocket Guide	Armed Forces Radiobiology Research Institute (AFRI)	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.	afri.usuhs.edu/sites/default/files/2020-07/afri-pocket-guide.pdf

Resource	Source	Description	Link
Find a Burn Center	Private (American Burn Association)	An expert referral center for burn patients. Telemedicine consults may be available.	https://ameriburn.org/resources/find-a-burn-center/
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.	afri.usuhs.edu/sites/default/files/2020-07/4edmmrhandbook.pdf

Resource	Source	Description	Link
Medical Reserve Corps (MRC)	HHS Administration for Strategic Preparedness and Response (ASPR)	A national network of more than 200,000 volunteers, organized locally to improve the health and safety of their communities. Jurisdictions are responsible for organizing and managing their MRC cadre, unlike DMAT which is managed at the federal level.	https://aspr.hhs.gov/MRC/Pages/index.aspx
Protective Action Guide Manual	EPA	Radiation dose guidelines that would trigger public safety measures, such as evacuation or staying indoors, to minimize or prevent radiation exposure during an emergency.	https://www.epa.gov/radiation/protective-action-guides-pags
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, cutaneous radiation syndrome (CRS), and countermeasure guidance.	www.cdc.gov/nceh/radiation/emergencies/index.htm?CDC_AA_refVal=https%3A%2F%2Femergency.cdc.g
Radiation Emergency Assistance Center/Training Site (REAC/TS)	DOE	Provides emergency response and subject matter expertise on medical management of radiation incidents. Also provides continuing medical education, outreach exercises, clinical information, and training opportunities. Also 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.	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

Resource	Source	Description	Link
Radiation Sickness	Mayo Clinic	Briefly and succinctly describes symptoms, diagnosis, and treatment of radiation sickness.	www.mayoclinic.org/diseases-conditions/radiation-sickness/diagnosis-treatment/drc-20377061
Radiation Treatment Injury Network (RITN)	Private	A consortium of US hospitals preparing for the medical surge resulting from a radiological incident. RITN hospitals prepare to provide specialized care to patients with Acute Radiation Syndrome (ARS) following a mass casualty radiological incident. RITN expertise is for “radiation only” injuries - trauma patients should be sent to other NDMS hospitals	ritn.net/treatment
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.	remm.hhs.gov/index.html
Strategic National Stockpile	HHS ASPR	A federal cache of MCMs and supplies that can be accessed and deployed for large public health disasters.	https://aspr.hhs.gov/NS/Pages/default.aspx

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4596 **Table 33: Mortuary Examiner/Coroner Resources**

Resource	Source	Description	Link
Disaster Mortuary Operational Response Teams(DMORT)	HHS	<p>DMORTs provide technical assistance and consultation on fatality management and mortuary affairs. DMORTs can:</p> <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 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 	www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/dmort.aspx
Guidelines for Handling Decedents Contaminated with Radioactive Materials	CDC	<p>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.</p>	www.cdc.gov/nceh

Resource	Source	Description	Link
Management of Dead Bodies after Disasters: A Field Manual for First Responders	PAHO, WHO, ICRC, IFRC ⁸⁵	Provides practical, easy-to-follow guidelines for first responder to promote dignified and proper management of dead bodies and facilitate their identification.	www.paho.org/disasters/dmdocuments/DeadBodiesFieldManual-2ndEd.pdf
Medical Examiner/Coroner's Guide for Contaminated Deceased Body Management	American Journal of Forensic Medicine and Pathology	Provides information and suggestions for decontamination procedures, specifically developed for ME/C audience.	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 for ME/Cs handling body or human remains that are potentially contaminated with radioactive material from a transportation incident involving radioactive material.	www.hsd.org/?view&did=764068
NCRP Report No. 161	National Council on Radiation Protection and Measurements (NCRP)	Offers guidance on handling persons contaminated with radionuclides.	ncrponline.org/publications/reports/ncrp-report-161

⁸⁵ 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 (IFRC)

Resource	Source	Description	Link
Victim Information Center (VIC) Teams	HHS	<p>VIC teams provide technical assistance for collection and management of postmortem data and related issues. VIC teams can:</p> <ul style="list-style-type: none"> collect dental records, medical records, DNA, and other postmortem 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 data to facilitate victim identification manage the missing persons list update the Victim Identification Program (VIP) database coordinate the release of remains 	<p>www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/vic.aspx</p>

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4598 **Annex G: Acronyms**

4599	ADA	Americans with Disabilities Act
4600	AFRRI	Armed Forces Radiobiology Research Institute
4601	ALARA	As Low As Reasonably Achievable
4602	AMS	Aerial Measuring System
4603	ARS	Acute Radiation Syndrome
4604	ASPECT	Airborne Spectral Photometric Environmental Collection Technology
4605	ASPR	Administration for Strategic Preparedness and Response
4606	ATSDR	Agency for Toxic Substances and Disease Registry
4607	CAM	Continuous Air Monitor
4608	CBRN	Chemical, Biological, Radiological, and Nuclear
4609	CDC	Centers for Disease Control and Prevention
4610	CEDS	Comprehensive Economic Development Strategy
4611	CERCLA	Comprehensive Environmental Response Compensation and Liability Act
4612	CFR	Code of Federal Regulations
4613	CI	Critical Infrastructure
4614	CISA	Cybersecurity and Infrastructure Security Agency
4615	CMHT	Consequence Management Home Team
4616	CMRT	Consequence Management Response Team
4617	CRC	Community Reception Center
4618	CRC-STEP	Community Reception Center Simulation Tool for Evaluation and Planning
4619	CRCPD	Conference of Radiation Control Program Directors
4620	CRS	Cutaneous Radiation Syndrome

4621	CST	Civil Support Team
4622	DCGL	Derived Concentration Guideline Level
4623	DHS	U.S. Department of Homeland Security
4624	DMAT	Disaster Medical Assistance Team
4625	DMORT	Disaster Mortuary Operational Response Teams
4626	DOE	Department of Energy
4627	DOT	Department of Transportation
4628	D-SNAP	Disaster Supplemental Nutrition Assistance Program
4629	DQA	Data Quality Assessment
4630	DRZ	Dangerous Radiation Zone
4631	DTRA	Defense Threat Reduction Agency
4632	EAS	Emergency Alert System
4633	EMAC	Emergency Management Assistance Compact
4634	EMP	Electromagnetic Pulse
4635	EMS	Emergency Medical Services
4636	EOC	Emergency Operations Center
4637	EPA	Environmental Protection Agency
4638	ERTU	FBI Evidence Response Team Unit
4639	FAQ	Frequently Asked Questions
4640	FBI	Federal Bureau of Investigation
4641	FCO	Federal Coordinating Officer
4642	FDRC	Federal Disaster Recovery Coordinator
4643	FEMA	Federal Emergency Management Agency
4644	FERN	Food Emergency Response Network

4645	FIOP	Federal Interagency Operational Plan for Response and Recovery
4646	FRMAC	Federal Radiological Monitoring and Assessment Center
4647	FSLTT	Federal, State, Local, Tribal, and Territorial
4648	GIS	Geographic Information Systems
4649	GM	Geiger Mueller
4650	GPS	Global Positioning System
4651	HASP	Health and Safety Plan
4652	HAZMAT	Hazardous Material
4653	HAZWOPER	Hazardous Waste Operations and Emergency Response
4654	HEPA	High Efficiency Particulate Air
4655	HERT	Hazardous Evidence Response Team
4656	HHS	Department of Health and Human Services
4657	HVAC	Heating, Ventilation and Air Conditioning Systems.
4658	HZ	Hot Zone
4659	IAEA	International Atomic Energy Agency
4660	IAPPG	Individual Assistance Program and Policy Guide
4661	ICRC	International Committee of the Red Cross
4662	ICRP	International Commission on Radiological Protection
4663	ICS	Incident Command System
4664	IFRC	International Federation of Red Cross and Red Crescent Societies
4665	IMAAC	Interagency Modeling and Atmospheric Assessment Center
4666	IND	Improvised Nuclear Device
4667	IPAWS	Integrated Public Alert and Warning System
4668	IT	Information Technology

4669	ITRC	Interstate Technology & Regulatory Council
4670	JIC	Joint Information Center
4671	LDRM	Local Disaster Recovery Manager
4672	LLRW	Low-Level Radioactive Waste
4673	MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
4674	ME	Medical Examiner
4675	MERS	Mobile Emergency Response Support
4676	MRC	Medical Reserve Corps
4677	NAREL	National Analytical Radiation Environmental Laboratory
4678	NCRFO	National Center for Radiation Field Operations
4679	NCRP	National Council on Radiation Protection and Measurements
4680	NDA	National Defense Area
4681	NDMS	National Disaster Medical System
4682	NDRF	National Disaster Recovery Framework
4683	NIMS	National Incident Management System
4684	NNSA	National Nuclear Security Administration
4685	NNSS	Nevada National Security Site
4686	NRC	Nuclear Regulatory Commission
4687	NRF	National Response Framework
4688	NRIA	Nuclear Radiological Incident Annex
4689	NSA	National Security Area
4690	NUSTL	National Urban Security Technology Laboratory
4691	NYC	New York City
4692	ORNL	Oak Ridge National Laboratory

4693	OSWER	Office of Solid Waste and Emergency Response
4694	PAG	Protective Action Guidance
4695	PAHO	Pan-American Health Organization
4696	PAS	Post-Disaster Recovery and Reconstruction
4697	PCB	Polychlorinated biphenyl
4698	PETS	Pets Evacuation and Transportation Standards Act of 2006
4699	POV	Personally Owned Vehicle
4700	PPE	Personal Protective Equipment
4701	PRD	Personal Radiation Detector
4702	PRG	Preliminary Remediation Goals for Radionuclides
4703	PTSD	Post-Traumatic Stress Disorder
4704	RAMP	Radiation Protection Computer Code Analysis and Maintenance Program
4705	RAP	Radiological Assistance Program
4706	RCRA	Resource Conservation and Recovery Act
4707	RDD	Radiological Dispersal Device
4708	REAC/TS	Radiation Emergency Assistance Center/Training Site
4709	REMM	Radiation Emergency Medical Management
4710	REP	Radiological Emergency Preparedness
4711	RERT	Radiological Emergency Response Team
4712	R-HASP	Radiation Health and Safety Plan
4713	RHSO	Radiation Health and Safety Officer
4714	RIID	Radionuclide Identification Device
4715	RITN	Radiation Injury Treatment Network
4716	RN	Radiological and Nuclear

4717	ROSS	Radiological Operations Support Specialist
4718	RRLT	Radiological Recovery Logistics Tool
4719	RSF	Recovery Support Function
4720	RSO	Radiation Safety Officer
4721	SAP	Sampling and Analysis Plan
4722	SDRC	State Disaster Recovery Coordinator
4723	SIP	Shelter-in-Place
4724	SLTT	State, Local, Tribal and Territorial
4725	SME	Subject Matter Expert
4726	SNS	Strategic National Stockpile
4727	TDRC	Tribal, or Territorial Disaster Recovery Coordinator
4728	TEDE	Total Effective Dose Equivalent
4729	TEPP	Transportation Emergency Preparedness Program
4730	TWG	Technical Working Groups
4731	UC	Unified Command
4732	UK	United Kingdom of Great Britain and Northern Ireland
4733	U.S.	United States
4734	USDA	United States Department of Agriculture
4735	VBIED	Vehicle-borne Improvised Explosive Device
4736	VIC	Victim Information Center
4737	VIP	Victim Identification Program
4738	VOAD	Voluntary Organization Active in Disaster
4739	VSP	Visual Sample Plan
4740	WEA	Wireless Emergency Alert

4741	WEST	RDD Waste Estimation Support Tool
4742	WHO	World Health Organization
4743	WMD	Weapons of Mass Destruction
4744	WMP	Waste Management Planning