**Background**

It can be argued that the most important aspect of an all-hazards plan is situational awareness because a good sense of capability and capacity to respond to a disaster enhances operations to ultimately save more lives. Should a radiological/nuclear (RN) incident occur in the United States, communities at the local level will be immediately overwhelmed and require broad support from all levels of government. Part of situational awareness is to recognize how well individual communities understand their vulnerabilities and how to leverage cross-jurisdictional, state, and Federal resources and assets in order to fill in immediate gaps of response & recovery operations. This report is intended to increase awareness of where there is a need to expand existing programs on radiation preparedness.

In the United States there are 100 nuclear power plants which comprise nearly 20 percent of the country’s domestic power created annually\(^1\). These reactors are dispersed over 31 states often in groups of two per site spanning a large number of local jurisdictions (Figure 1). Two separate emergency planning zones (EPZs) have been designated surrounding nuclear power plants to maintain the highest level of preparedness for a potential radiation emergency: the 10 mile exposure pathway EPZ and the 50 mile ingestion pathway EPZ.

Through the partnership between the Nuclear Regulatory Commission (NRC), FEMA, and state and local governments within the 10 mile EPZ, predetermined plans are in place and exercised annually. In addition every effort is made to keep the populace within this zone is informed on what to do in the event of an emergency.

The 50 mile EPZ has less concrete planning requirements in the event of a RN incident. A literature review illustrates a shortage of studies or guidance on planning for nuclear emergencies outside of the 10 mile EPZ. The only guidance provided for how local jurisdictions within the 50 mile EPZs should prepare states that “predetermined protective plans [need to be] in place for this EPZ and are designed to avoid or reduce dose from potential ingestion of radioactive materials.” Furthermore, “plans for ingestion pathway shall focus on such actions as are appropriate to protect the food ingestion pathway\(^2,3\).” These guidance documents focus on the downstream threat of potential R/N exposure following a radiation emergency. Besides such general guidance available from Federal resources, few, if any, recommended planning activities available to allow
local governments to carry forth with developing their own radiation preparedness plan or annex; an exception are states that have created their own plans in relation to the 50 mile EPZ.

The responsibility of the local governments in the 50 mile EPZ will not only be the ingestion pathway. A radiological emergency encompasses almost every aspect of all-hazards planning. As the population evacuates, jurisdictions will receive potentially contaminated people, animals, and material goods, in addition to the potentially contaminated modes of transportation. Locals will be the first to receive displaced populations and care for them, holding responsibility for communication, reception, screening, monitoring, decontamination, sheltering, mass care services, points of dispensing (POD), and environmental health services.

Figure 1. Map summarizing the distribution of nuclear power plants, Radiation Injury Treatment Network (RITN) hospitals, and ongoing radiation emergency preparedness activities by the Federal Emergency Management Agency (FEMA) within the 10 designated FEMA regions. Counties within the designated 10 and 50 mile Nuclear Regulatory Commission Emergency Planning Zones (EPZ) shaded as indicated in the legend.

The level of preparedness required for this type of event is greater than other hazards, yet we do not have the awareness of preparedness efforts at the local level. This assessment provides a baseline understanding of preparedness levels of local jurisdictions in the 50 mile EPZs across the country.

Project Scope

This project focuses on public health preparedness coordinators’ radiological emergency planning practices, their awareness of radiological/nuclear (RN) threats, and their familiarity with the Radiation Injury Treatment
Network (RITN) within 50 mile EPZs. Utilizing geographical information system (GIS) mapping, 1,446 preparedness coordinators, which represent approximately 51.6% of the nearly 2,800 preparedness coordinators nationwide, fall within the target area (Figure 1).

**Project Goals**

The National Association of County and City Health Officials (NACCHO), on behalf of the RITN, investigated public health preparedness coordinators’ level of awareness and practices with the following research questions:

1) To what extent are preparedness coordinators in the target area aware of nuclear plants and involved in mitigation and planning activities for potential radiation emergencies?
2) What capabilities do preparedness coordinators in the target area possess?
3) What level of awareness and interaction do the preparedness coordinators in the target area have with the RITN?

![Figure 2. State locations of interviewed key informants.](image)

To address these questions, NACCHO first conducted interviews with subject matter experts who spanned a breadth of experience and knowledge to identify trends in radiation preparedness (Figure 2). These trends led to the design of the questions for the survey of which resulted in three sections:
• Risk assessment – analyze the perceived level of threat radiological emergencies pose to the jurisdiction and the level of response planning;
• Response Capabilities – assess the amount of resources the jurisdiction possess to respond to a radiological emergency;
• Radiation Injury Treatment Network – understand preparedness coordinators’ awareness and interaction with the RITN.

Project Objectives

The objective of this project is to address areas for improvement in radiation emergency preparedness within the 50 mile EPZ by:

1) Increasing the understanding of the preparedness coordinators’ awareness of radiation emergency concerns surrounding nuclear power plants;
2) Enhancing the understanding of the nuclear incident response capabilities of preparedness coordinators and available mitigation and planning activities;
3) Expanding the level of awareness and interaction of preparedness coordinators with the RITN.

Response Rate

Drawing from our recent research into the location of preparedness coordinators in our target area of 50 mile EPZs around nuclear power plants, the survey was distributed to 600 out of the total 1,446 preparedness coordinators.

Figure 3. State locations of every respondent.
coordinators in the 50 mile EPZ. There were 213 preparedness coordinators or equivalent who completed the survey out of the 600 recipients, for a response rate of 35.5 percent. Figure 3 highlights the states from which every respondent is located.

**Risk Assessment**

The first section of questions focused on the risk assessment of a radiological emergency to jurisdictions, what is perceived as the level of threat radiological emergencies pose, and what has already been done to mitigate these threats. Only one quarter of respondents (25.7%) indicated radiological emergency planning as a high priority. Meanwhile, roughly 75% of respondents did not believe this risk was a high priority. The primary reasons for this assertion, highlighted in Figure 4, are limited resources (62%), closely followed by the indication that a radiological emergency was considered a low risk on the Hazard Vulnerability Assessment (57.3%). Meanwhile 24.7 percent indicated that there is no funding available for radiation emergency preparedness. When prompted, participants were able to expand on their responses if they specified other reasons. Many of the responses included that health departments would not be the lead in response, or describe that their limitations in experienced and capable staff capacities were large enough barriers to impede radiation emergency preparedness planning. Another frequent response reflected the perception that a radiological emergency would not impact their area.

When respondents were asked whether they had any plans in place for a radiological emergency, the two most common plans are medical countermeasure distribution and sheltering (Figure 5). One result to note is 13 percent still have no plans for a radiological event. Some jurisdictions in the 50 mile EPZ stated that they completed a working plan only within the past year. A primary explanation for the lack of prior radiation emergency preparedness was the work plan for their PHEP grant had not been allocated for
radiation, making it difficult to find the time and justification. None of these counties have been included in the 10 mile EPZ planning and exercises either. According to the survey question on whether the 50 mile EPZs are included in the 10 mile planning and exercising, there is only a 26.8 percent inclusion rate. Preparedness coordinators in the 50 mile EPZ in one state mentioned having tried to work together to begin their radiation planning, but with little guidance on priorities for where to focus efforts and what exactly needs to be included, progress has been delayed until recently.

According to the survey question on whether the 50 mile EPZs are included in the 10 mile planning and exercising, there is only a 26.8 percent inclusion rate. Preparing coordinators in the 50 mile EPZ in one state mentioned having tried to work together to begin their radiation planning, but with little guidance on priorities for where to focus efforts and what exactly needs to be included, progress has been delayed until recently.

<table>
<thead>
<tr>
<th>Medical Countermeasure Distribution (%)</th>
<th>Ingestion Pathway (%)</th>
<th>Community Reception Centers (%)</th>
<th>Sheltering (%)</th>
<th>Other Screening and Decontamination (%)</th>
<th>Animal Decontamination (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>16.3</td>
<td>4.0</td>
<td>8.9</td>
<td>12.8</td>
<td>4.8</td>
</tr>
<tr>
<td>2 years</td>
<td>13.1</td>
<td>6.7</td>
<td>15.9</td>
<td>15.4</td>
<td>12.2</td>
</tr>
<tr>
<td>3-5 years</td>
<td>28.1</td>
<td>10.1</td>
<td>20.4</td>
<td>19.2</td>
<td>10.2</td>
</tr>
<tr>
<td>6-7 years</td>
<td>1.3</td>
<td>4.7</td>
<td>2.6</td>
<td>1.9</td>
<td>0.7</td>
</tr>
<tr>
<td>8 years</td>
<td>5.0</td>
<td>4.7</td>
<td>4.5</td>
<td>5.8</td>
<td>4.1</td>
</tr>
<tr>
<td>Not Exercised</td>
<td>20.0</td>
<td>39.6</td>
<td>24.8</td>
<td>25.0</td>
<td>38.1</td>
</tr>
<tr>
<td>Unsure</td>
<td>16.2</td>
<td>30.2</td>
<td>22.9</td>
<td>19.9</td>
<td>29.9</td>
</tr>
</tbody>
</table>

Table 1 illustrates for those with plans, how often they are exercised. Time intervals were chosen to reflect the requirements set for various types of exercises and further breakdown. For example, FEMA requires a HSEEP-compliant, FEMA-evaluated exercise within the 10 mile EPZ every two years, while the ingestion pathway must be exercised every eight years for states within the 50 mile EPZ. There does not seem to be a common trend in the frequency of exercises.

As public health departments in 50 mile EPZs will have to respond or assist with more than just ingestion pathway monitoring, preparedness coordinators were asked what they believe would overwhelm their operations. Approximately two thirds said the reception, decontamination, and sheltering of evacuees might overwhelm their response (Figure 6). When these potentially contaminated evacuees egress to these surrounding jurisdictions, potentially contaminated vehicles and material goods are also in accompaniment. There is also the potential of further contamination of the infrastructure (e.g. buildings, public transportation).

Undoubtedly a cause for concern, these issues are reflected in Figure 4; most prominently, 65 percent believe simply handling environmental

![Figure 6](https://via.placeholder.com/150)
contamination could overwhelm operations. Even for ingestion pathway response, 47.9 percent feel as though this would strain resources.

**Response Capabilities**

Following risk assessment and an overview of current/ongoing radiation emergency preparedness activities, survey questions transitioned into the next section regarding capabilities. Preparedness coordinators were asked what their health department’s role in the response of a radiological emergency would be. Assisting vulnerable populations (48.8%) and conducting environmental monitoring (35.2%) were seen as their major roles. One quarter of respondents saw the health department’s role in long-term monitoring. In the text portion to describe an “other” response, many said that medical countermeasure distribution, assisting with community reception centers or shelters, and public messaging would be perceived as their role. Of concern, several respondents indicated that they do not see local public health playing a major role in response, only to assist other agencies. To understand the number of staff local health departments have to fill these roles, Figure 7 shows how many are trained to respond to a radiological emergency.

![Figure 7. Number of staff in the organization trained to respond to a radiological emergency.](image)

In regard to capacities surrounding equipment, 33.8 percent have handheld dosimeters, but 53 percent do not possess any radiological equipment. To compensate for a lack of available resources, health departments have Memoranda of Understanding (MOU) or Memoranda of Agreement (MOA) in place, and partner with a number of other organizations for a more comprehensive response should a radiological emergency occur. The most common department a standing MOU/MOA is kept with is the local fire department. Besides being a first response team, HAZMAT teams are in possession of a variety of equipment useful in screening and decontaminating materials. The state emergency management agency may also own response equipment, in addition to increasing staffing capacities. While over 66 percent of health departments hold an MOU/MOA with the aforementioned partners, more assistance needs to be provided for the remaining one third to take this simple
step in better preparing for not only a radiological emergency, but any emergency. A greater untapped resource is hospitals, housing the breadth of knowledge in nuclear medicine technologists and medical health physicists. Almost one third have MOUs/MOAs in place to call upon these subject matter experts in a radiation event, but more education is needed to raise the awareness of this overlooked resource existing in every jurisdiction.

As an extension of the above, survey responders were asked about the partnerships local health departments have with organizations at all levels, illustrated in Table 2. In addition to partnerships, we wanted to see if jurisdictions had designated radiation experts. While only 10.7 percent have a radiation task force within their jurisdiction, 47.7 percent have access to one in their state. Sixteen percent are equipped with a radiation subject matter expert as well.

The Nuclear Regulatory Commission (NRC) is another partnership that has the potential to boost response capacities by increasing resources for local health departments and other local agencies. Twenty nine percent of the respondents indicated having a partnership with the NRC. Out of these, 67.3 percent also worked with the 10 mile EPZ; 20 percent of those who partner with the NRC do not work with the 10 mile EPZ.

We know that EPZs surrounding nuclear power plants span across jurisdictions and state lines, signifying the importance of collaboration across governing lines in a response to a radiological event. Almost 55 percent are working with other jurisdictions across county lines within a state. For those across states, only 25.4 percent have partnerships established.

Radiation Injury Treatment Network

The RITN will play a large role in the event of a radiological emergency. The potentially surmountable role to save lives quickly could depend on the percentage of jurisdictions which are aware of the RITN and have an active understanding and partnership with the network. The results of the questions regarding this section are included in Table 3. Only those respondents who chose ‘yes’ for the questions of whether they were aware of the RITN could

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Number with partnerships (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Emergency Management Agency</td>
<td>136 (63.9)</td>
</tr>
<tr>
<td>State Emergency Management Agency</td>
<td>107 (50.2)</td>
</tr>
<tr>
<td>State Health Department</td>
<td>116 (54.5)</td>
</tr>
<tr>
<td>Fire Department</td>
<td>121 (56.8)</td>
</tr>
<tr>
<td>Law Enforcement</td>
<td>101 (47.4)</td>
</tr>
<tr>
<td>Medical Reserve Corps</td>
<td>69 (32.4)</td>
</tr>
<tr>
<td>Department of Transportation</td>
<td>31 (14.6)</td>
</tr>
<tr>
<td>School System</td>
<td>64 (30.1)</td>
</tr>
<tr>
<td>Hospitals/Healthcare Coalitions</td>
<td>87 (40.9)</td>
</tr>
<tr>
<td>Federal Agencies</td>
<td>27 (12.7)</td>
</tr>
<tr>
<td>Other</td>
<td>22 (10.3)</td>
</tr>
</tbody>
</table>

Respondents could choose >1 response.

Table 2. Agencies in partnership with respondents’ organization.

Table 3. Awareness and interaction with the Radiological Injury Treatment Network

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>Unsure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you aware of the RITN? (n=199)</td>
<td>19.1</td>
<td>80.9</td>
<td></td>
</tr>
<tr>
<td>Is there a RITN center in your jurisdiction? (n=38)</td>
<td>30.8</td>
<td>41.0</td>
<td>28.2</td>
</tr>
<tr>
<td>Does your jurisdiction partner with a RITN center? (n=38)</td>
<td>34.2</td>
<td>34.2</td>
<td>31.6</td>
</tr>
<tr>
<td>Does your state partner with a RITN center? (n=38)</td>
<td>42.1</td>
<td>0</td>
<td>57.9</td>
</tr>
<tr>
<td>Do you include RITN in other types of radiological emergency planning?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e.g., IND, RDD, lost/orphaned)? (n=38)</td>
<td>23.7</td>
<td>34.2</td>
<td>42.1</td>
</tr>
</tbody>
</table>
continue to answer the remaining questions. Just over 19 percent of the respondents were aware of the RITN. Out of this 19.1 percent, 30.8 percent had a RITN center in their jurisdiction, and 34.2 percent partnered with a RITN center. Forty two percent said their state holds a partnership with a RITN center. We also included a question about the involvement of the RITN in plans for other types of radiological emergencies (e.g., IND, RDD); 23.7 percent have the RITN included in these plans.

**Summary**

Local jurisdictions in the 50 mile EPZ will play a major role in the response should an emergency occur at a nuclear power plant. Currently, the NRC only discuss the role of monitoring the ingestion pathway for this zone. Though the Centers for Disease Control and Prevention (CDC) and other Federal agencies provide resources on specific areas of preparedness (e.g., community reception centers, sheltering, mass care services) for the 50 mile EPZ, no studies have been done in this area to provide a level of understanding on their preparedness. This assessment provides a baseline awareness of preparedness as well as the variabilities in different zones across the country.

Radiological emergency preparedness is not a high priority for approximately three quarters of jurisdictions, with limited resources being the most common reason. Budget cuts have plagued local health departments since 2008, resulting in a loss of 44,000 jobs and the emergency preparedness program falling in one of the top programs to receive a reduction in services. A combination of lost funding and subsequent attrition of important public health positions further adds to the root causes of why radiological emergency planning is not a high priority; and reflected in the majority of these jurisdictions having zero to five staff of which are well versed in radiological emergencies.

To compensate for the lost capacities, building strong partnerships before an emergency occurs is crucial to a robust response. Local health departments may not be the primary responder in a radiological incident; their role will be to assist with vulnerable and hard to move populations (e.g., hospitals, nursing homes), medical countermeasure distribution, long term monitoring, and assist in other areas like reception and sheltering. Table 2, though not an exhaustive list, highlights several agencies to form partnerships with. The following quote highlights the need for strong partnerships and a robust situational awareness of the complexities surrounding the response to a radiation emergency.

*If the bomb is in Manhattan, we would move people west either by bus or train or ferry boat into New Jersey, process them here, then load them onto either bus or train, and then we ship them across state to house them in Pennsylvania...[The plan] covers four states: Connecticut, New York, Pennsylvania, and New Jersey [to cover] how we would respond to the one incident in New York because, again you’re moving so many people, all of those jurisdictions – where do you send them, where do you house them – transportation gets complicated.*
A key informer from Florida also discussed similar inclusive plans amongst their counties, a reflection of the level of collaboration all zones should have surrounding every nuclear power plant. The two counties, or what they call “risk counties,” in the 10 mile EPZ will evacuate to the three surrounding “host counties” within the 50 mile EPZ. These plans are exercised annually, with the inclusion of the counties in the 50 mile EPZ every time.

The jurisdictions in the 10 mile EPZ have an extra advantage of holding a partnership with the NRC and the nuclear power plant utilities themselves. The 50 mile EPZ in New Hampshire, for example, will hold open trainings for anyone in either EPZ or conduct a radiation-related exercise once per year, but it is not the other way around. If both EPZs could work together on radiation planning, it would reduce the burden on the already strained local governments. As described above, 13 percent of jurisdictions have no radiological emergency plans. The majority of these were in Connecticut, Massachusetts, and New Hampshire, states in which have a city or area-based governance structure instead of counties. In this structure, local health departments may only have a handful of staff for their entire operations, with no extra capacity to take on radiation planning. Partnering with jurisdictions around them will improve preparedness for all involved.

Looking back at the displaced population from Hurricane Katrina and the widespread relocation efforts underscores the importance of expanding partnerships and not just focusing efforts in areas surrounding the potential hazard. In just one month after the hurricane devastated New Orleans, evacuees made their way to every state (Figure 8). Thinking in terms of a radiological emergency, the rapid efflux of evacuees to
surrounding counties and states, in addition to the potential spread of contamination, could affect any jurisdiction.

Difficulties still remain for the jurisdictions with plans. The main concern of the 10 mile EPZ at the time of an event is public communication and evacuation (followed by environmental contamination monitoring, reduction, and cleanup etc.). The 50 mile EPZ will receive the evacuees, have to screen and potentially decontaminate, reunify families, shelter, provide mass care services, potentially relocate, and more – these local jurisdictions within the 50 mile EPZ potentially serving as the first line of response. Looking at [Tables 2 and 3], there is little consistency in the types of plans in place and the frequency in which they are exercised. As some respondents indicated, there is no set guidance on what the 50 mile EPZ should be doing or where to start. Even though the NRC focuses on the ingestion pathway, there is little guidance on formulating these plans. The language used also only includes state whom are required to exercise the ingestion pathway plans every eight years. It is possible that the local level may not be included in the state plans, and the locals are left to recreate the plans themselves.

In addition to monitoring radiation levels in the environmental or external low-dose contamination on evacuees (more typical in an improvised nuclear device or radiological dispersal device scenario), internal exposure is of significant concern in a radiological emergency. Depending on the dose and type of radiation, and the mode of exposure, acute radiation syndrome may manifest in the population nearest to the incident, or in those who ingested contaminated materials. Symptoms can take hours to weeks to manifest, implications for jurisdictions in the 50 mile EPZ receiving these evacuees for another aspect to screen and monitor for. Evacuees found to have internal contamination should be sent to one of the 75 Radiological Injury Treatment Network (RITN) centers for treatment; however, only 19 percent of local jurisdictions are aware of this network. There are potential jurisdictions with a RITN center in their area or even their state and are unaware. The key informant interviewees who were aware of the RITN stated that they believed the partnership and interaction was the responsibility of the state or the hospitals. Only one key informant knew where the closest RITN center was to their jurisdiction.

Based on the above findings, there is concern that information on the RITN or the National Disaster Medical System (NDMS) may not be disseminated down to or across the local level, especially with the high turnover rate in these positions. Services from the NDMS can only be requested by a state governor when local or county authorities advise the need. If there is a lack of understanding of this system structure, patients who need swift attention from a RITN center may not receive the appropriate care in time. Even if local authorities are aware of the NDMS, we know that with limited resources and the concern of operations becoming overwhelmed in the response to a radiological emergency, advice reaching up to the governor and the subsequent activation of the NDMS may be delayed. Evacuees with suspected internal contamination will instead be sent to local hospitals, a system that already may be overwhelmed with patients with physical injuries and the worried well, and may not have the capacities to treat radiation injuries.

Every aspect of the local level will play a part in response. If public health is not considered as a role, how will they link to the RITN and NDMS? To increase the awareness of the RITN and the NDMS, and reduce the
burden on the local level, outreach and education tailored to the local level should be focused on in a recurrent manor. The RITN holds one tabletop exercise every year, as well as a full-scale exercise at one center. Tabletop exercises and full-scale exercises could be expanded to include public health and other local authorities outside of the 10 mile EPZs and major cities to increase awareness and improve knowledge.

Radiation emergency planning encompasses every aspect of preparedness: communication, medical countermeasures and points of dispensing (PODs), reception of displaced populations, environmental health services, mass care, sheltering, relocation and reunification. A jurisdiction prepared for a radiological emergency is better prepared for all hazards. If we foster radiological planning across the country and the partnerships therein, we will be well prepared as a whole.

**Recommendations**

With an understanding of the baseline preparedness at the local level, best practices as well as gaps have been identified to pursue further. To address the gaps in radiation response planning, the first step is to develop a guidance for local jurisdictions in the 50 mile EPZ. This guidance document will focus on the priorities in which efforts should be focused upon to begin the planning process. Tools and resources provided by the federal level should be tailored to inform practices at the local level, especially for public health. These materials can be compiled into a toolkit for dissemination to and access by local public health officials. In addition to resources and tools for planning, GIS mapping can be utilized for situational awareness of potential hazards and scenarios.

To improve awareness and interaction with the RITN, RITN exercises can be expanded or tailored to include local officials, especially public health. If possible, 10 mile EPZ exercises should also be expanded to include 50 mile EPZs to improve awareness, partnership, and readiness in every aspect.

**Acknowledgements**

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