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**From:** GAO Reports [GAOReports@gao.gov]  
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**Subject:** Release of formerly restricted product: GAO-13-243, Emergency Preparedness: NRC Needs to Better Understand Likely Public Response to Radiological Incidents at Nuclear Power Plants, 361382

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GAO-13-243

**Emergency Preparedness: NRC Needs to Better Understand Likely Public Response to Radiological Incidents at Nuclear Power Plants**

<http://www.gao.gov/prerelease/0G94>

This report contains recommendations to your agency. As you know, 31 U.S.C. 720 requires the head of a federal agency to submit a written statement of the actions taken on our recommendations to the Senate Committee on Homeland Security and Governmental Affairs and to the House Committee on Oversight and Government Reform not later than 60 calendar days from the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 calendar days after that date. Since the congressional requester has asked that the distribution of the report be restricted, as provided by GAO's Congressional Protocols, the 60-day period begins on the date the report is released and e-mailed to you. Because agency personnel serve as the primary source of information on the status of recommendations, GAO requests that you also provide GAO with a copy of your agency's statement of action to serve as preliminary information on the status of open recommendations. Please send your statement of action to GIANOPOULOS, KIMBERLY M ([GianopoulosK@gao.gov](mailto:GianopoulosK@gao.gov)) or to me at ([RuscoF@gao.gov](mailto:RuscoF@gao.gov)).

We appreciate the assistance and cooperation of your staff during our review.

**Franklin W. Rusco**

**Director, Government Accountability Office: Natural Resources and Environment**

After public release later today, the following link should be used to obtain the product.

<http://www.gao.gov/products/GAO-13-243>

March 2013

# EMERGENCY PREPAREDNESS

## NRC Needs to Better Understand Likely Public Response to Radiological Incidents at Nuclear Power Plants



## EMERGENCY PREPAREDNESS

### NRC Needs to Better Understand Likely Public Response to Radiological Incidents at Nuclear Power Plants

#### Why GAO Did This Study

On March 11, 2011, a tsunami severely damaged the Fukushima Daiichi nuclear power plant in Japan and led to the largest release of radiation since the 1986 Chernobyl disaster. Japanese authorities evacuated citizens within 19 miles of the plant. GAO was asked to examine issues related to emergency preparedness at nuclear power plants. This report examines (1) federal, licensees', and local and state authorities' responsibilities in radiological emergency preparedness, (2) the activities NRC and FEMA take to oversee licensee and local and state radiological emergency preparedness, and (3) NRC and FEMA requirements for informing the public on preparedness and NRC's understanding of public awareness. GAO reviewed laws, regulations, and guidance; examined emergency plans from licensees and local and state authorities; visited four nuclear power plants; and interviewed federal, local and state, and industry officials.

#### What GAO Recommends

To better inform radiological emergency preparedness efforts, GAO recommends that NRC obtain information on public awareness and likely public response outside the 10-mile zone, and incorporate insights into guidance, as appropriate. NRC generally disagreed with GAO's finding, stating that its research shows public response outside the zone would generally have no significant impact on evacuations. GAO continues to believe that its recommendation could improve radiological emergency preparedness efforts and is consistent with NRC guidance.

#### What GAO Found

The U.S. Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) are collectively responsible for providing radiological emergency preparedness oversight and guidance to commercial nuclear power plant licensees and local and state authorities around the plants. In general, NRC is responsible for overseeing licensees' emergency preparedness at the plant (on-site), and FEMA is responsible for overseeing preparedness by local and state authorities around the plant (off-site). NRC and FEMA have also established a 10-mile emergency planning zone around nuclear power plants. Licensees are responsible for managing on-site radiological emergency preparedness and developing and maintaining plans that define activities that the nuclear power plant must take to prepare for and respond to a potential incident at the plant. Participating local and state authorities within the 10-mile zone must develop protective actions for responding to a radiological incident, including plans for evacuations and sheltering in place. A recent NRC task force considered the adequacy of the zone size and concluded that no change was currently needed but will be re-evaluated as part of its lessons learned efforts for the Fukushima incident.

NRC and FEMA conduct activities to ensure that licensees and local and state authorities have adequate plans and capabilities to respond to a radiological incident. For example, NRC and FEMA review emergency plans developed by licensees and local and state authorities to ensure that planning standards are met. In addition, NRC and FEMA observe exercises for each plant that licensees and local and state authorities conduct every 2 years to demonstrate their ability to respond to an incident. NRC also requires licensees to develop estimates of how long it would take for those inside the 10-mile zone to evacuate under various conditions. Licensees are to provide these evacuation time estimates to local and state authorities to use when planning protective action strategies.

NRC and FEMA require licensees and local and state authorities, respectively, to provide information annually on radiation and protective actions for the public only inside the 10-mile zone. Those in the 10-mile zone have been shown to be generally well informed about these emergency preparedness procedures and are likely to follow directions from local and state authorities in the event of a radiological emergency. In contrast, the agencies do not require similar information to be provided to the public outside of the 10-mile zone and have not studied public awareness in this area. Therefore, it is unknown to what extent the public in these areas is aware of these emergency preparedness procedures, and how they would respond in the event of a radiological emergency. Without better information on the public's awareness and potential response in areas outside the 10-mile zone, NRC may not be providing the best planning guidance to licensees and state and local authorities.



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# Contents

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Letter		1
	Background	4
	NRC and FEMA Guide Licensees and Local and State Authorities in Radiological Emergency Preparedness	9
	NRC and FEMA Oversee Radiological Emergency Preparedness by Reviewing Plans and Exercises	13
	NRC and FEMA Require That the Public within the 10-Mile Zone Be Informed Annually about Preparedness, but NRC Has Little Information about Public Awareness Outside This Zone	20
	Conclusions	25
	Recommendation for Executive Action	26
	Agency Comments and Our Evaluation	27
Appendix I	NRC and FEMA Planning Standards	30
Appendix II	Comments from the Nuclear Regulatory Commission	32
Appendix III	GAO Contacts and Staff Acknowledgments	33

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## Abbreviations

EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
KI	Potassium Iodide
NRC	Nuclear Regulatory Commission
REP	Radiological Emergency Preparedness

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United States Government Accountability Office  
Washington, DC 20548

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March 11, 2013

The Honorable Barbara Boxer  
Chairman  
Committee on Environment and Public Works  
United States Senate

The Honorable Sheldon Whitehouse  
Chairman  
Subcommittee on Oversight  
Committee on Environment and Public Works  
United States Senate

The Honorable Robert P. Casey, Jr.  
United States Senate

The Honorable Bernard Sanders  
United States Senate

In March 11, 2011, a 9.0-magnitude earthquake and subsequent tsunami devastated northeastern Japan and severely damaged the Fukushima Daiichi nuclear power plant. The resulting radiological emergency involved the most extensive release of radioactive material at a nuclear power plant since the 1986 Chernobyl disaster. Following this release, the Japanese government evacuated people within 12 miles of the plant, and later extended the evacuation to 19 miles. In total, almost 150,000 people were evacuated. On March 16, 2011, the U.S. Nuclear Regulatory Commission (NRC)—an independent federal agency that licenses the 104 U.S. commercial nuclear power reactors and regulates their safe operation and security—recommended that U.S. citizens within 50 miles of the Fukushima Daiichi plant evacuate.<sup>1</sup> NRC officials said that this recommendation was a conservative estimate based on limited and often

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<sup>1</sup>NRC grants licenses to companies that may operate more than one commercial nuclear power plant. For purposes of this report, we refer to both licensed companies and the physical power plants as licensees.

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conflicting information about the exact conditions of the reactors and spent fuel pools at the power plant.<sup>2</sup>

The Japanese experience raised questions in the United States about radiological emergency preparedness for commercial nuclear power plants,<sup>3</sup> particularly as populations near plants have grown. NRC and the Federal Emergency Management Agency (FEMA), within the Department of Homeland Security (DHS), are the two primary federal agencies responsible for radiological emergency preparedness for U.S. nuclear power plants and their surrounding areas. The Atomic Energy Act of 1954, as amended, requires that NRC grant licenses only when assured that the public's health and safety are adequately protected. In carrying out this requirement, NRC makes radiological health and safety determinations on the overall state of emergency preparedness for a commercial nuclear power plant site—both at the plant (on-site) and in the area surrounding the plant (off-site). FEMA is responsible for leading the nation's disaster preparedness activities. In the context of radiological preparedness, FEMA is responsible for assessing off-site preparedness and providing guidance and assistance to local and state authorities through its Radiological Emergency Preparedness (REP) program. In making its overall determinations about radiological public health and safety for a commercial nuclear power plant, NRC reviews FEMA's assessments of off-site emergency preparedness as part of NRC's licensing and regulatory requirements.

Federal preparedness guidance generally states that planning for evacuations should extend to 10 miles from the plant because NRC studies have shown that health risks to the public outside of 10 miles would be low in a radiological incident. NRC and FEMA officials told us that if conditions warranted, current planning would allow evacuation to occur beyond 10 miles. Nationwide, each of the 65 operating commercial nuclear power plants has a 10-mile emergency planning zone around the

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<sup>2</sup>In this report, when we use the term power plant, we are referring to an entire site, and nuclear power reactors are the individual units at each site. Some nuclear plants store spent nuclear fuel in specially designed pools of water, and a fire at a spent fuel pool could result in the widespread release of radiation.

<sup>3</sup>For the purposes of this report, radiological emergency preparedness involves a combination of planning, resources, training, conducting exercises, and organizing to build, sustain, and improve operational capabilities for responding to an incident at a commercial nuclear power plant.



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plant; in total, these zones include at least 490 local and state authorities, according to NRC and FEMA officials.<sup>4,5</sup> These plants and surrounding local and state authorities develop plans for evacuations and other protective actions, such as sheltering in place, to protect public health and safety during an incident in which there is a potential for radiological release.<sup>6</sup>

In this context, you asked us to review radiological emergency preparedness for commercial nuclear power plants. The objectives of this report were to (1) describe the roles and responsibilities of NRC and FEMA, the licensees, and local and state authorities for radiological emergency preparedness; (2) describe the actions NRC and FEMA take to oversee licensee and local and state radiological emergency preparedness; and (3) examine NRC and FEMA requirements for informing the public about preparedness and NRC's understanding of public awareness. This report focuses on NRC, FEMA, and local and state efforts inside the 10-mile emergency planning zone, where the majority of radiological emergency preparedness planning takes place.

To address these three objectives, we reviewed relevant federal laws and regulations and NRC and FEMA guidance documents, and local and state authorities' radiological emergency response plans associated with the four commercial nuclear power plants we visited including Indian Point Energy Center in New York, St. Lucie Nuclear Power Plant in Florida, and Limerick Generating Station in Pennsylvania. We selected this nonprobability sample of nuclear power plants based on multiple criteria. These criteria included plants that (1) had over 1 million people within 50 miles and over 200,000 people within 10 miles and (2) were located in different FEMA regions. In addition, we wanted to observe a plant conducting a radiological emergency preparedness exercise, which

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<sup>4</sup>For the purposes of this report, local and state authorities include any local, state, or tribal government; supporting private industry and voluntary organizations; and any other off-site response organization responsible for carrying out emergency functions in the area surrounding the plant during a radiological emergency.

<sup>5</sup>There are 104 operating reactors at the 65 operating commercial power plants.

<sup>6</sup>Protective actions include measures to avoid or reduce the public's exposure to radiation from a release of radioactive material, such as sheltering in place, evacuation, and/or use of potassium iodide (KI) in pill or liquid form.

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each plant must conduct once every 2 years.<sup>7</sup> Congressional requesters also expressed interest that we increase our regional sample by visiting a plant outside of the East Coast. As a result, we selected the San Onofre Nuclear Generating Station because it was the only plant outside the East Coast that met some of our criteria, including that it has the second highest population in the country within 50 miles of a plant. We interviewed NRC and FEMA officials from headquarters and the regional offices in which the plants were located, the Environmental Protection Agency (EPA), licensee officials for the four plants we visited, and local and state authorities responsible for emergency preparedness in areas around the plants. We observed a radiological emergency preparedness exercise to determine how the licensee and federal, local, and state stakeholders conduct and evaluate preparedness exercises. We also reviewed the four power plants' studies of estimated times for evacuation from the area around the plants to understand how these studies inform updates to local and state radiological emergency response plans. To determine how radiological emergency preparedness information is to be communicated to the public, we reviewed NRC and FEMA guidance on how licensees and local and state authorities should provide information to the public. We also interviewed federal, state, and local officials to understand how the public is informed of evacuation planning and radiological emergency preparedness.

We conducted this performance audit from February 2012 to March 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Background

The key federal agencies involved in emergency preparedness at commercial nuclear power plants include NRC and FEMA. NRC makes radiological health and safety determinations on the overall state of emergency preparedness for a commercial nuclear power plant site—both at the plant (on-site) and in the area surrounding the plant (off-site).

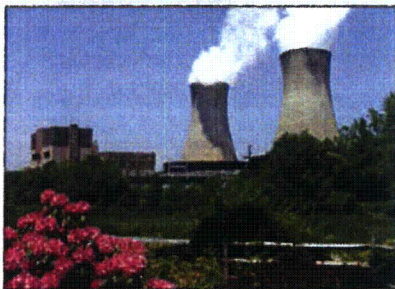
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<sup>7</sup>Because this was a nonprobability sample, the information collected during these site visits cannot be generalized to all 65 commercial nuclear power plants but provides illustrative information.

In addition, FEMA is responsible for providing guidance and assistance to local and state authorities and for assessing off-site radiological emergency preparedness and communicating those assessments to NRC. EPA also supports radiological emergency preparedness by developing a radiation guide that helps licensee officials and local and state authorities make decisions during a radiological incident at a commercial nuclear power plant.

## Emergency Planning Zones

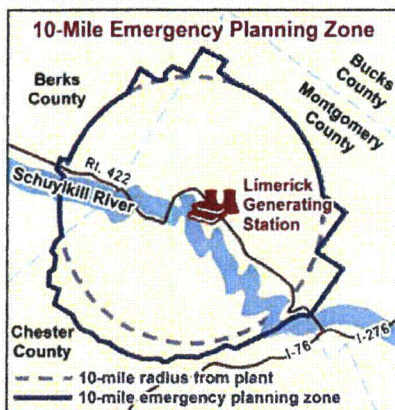
Limerick Generating Station – Limerick, PA



Sources: GAO and Exelon Corporation.

- **Population in 10-mile emergency planning zone:** 252,000
- **Location:** 21 miles NW of Philadelphia, PA
- **Generation:** Two reactors generate about 2,345 megawatts total, which is enough to power more than 2 million homes, according to the licensee.
- **Licenses issued:** Unit 1 – 8/08/1985  
Unit 2 – 8/25/1989
- **Licenses' expiration:** Unit 1 – 10/26/2024  
Unit 2 – 6/22/2029

**Note:** Pennsylvania policy calls for a single protective action for the entire 10-mile planning zone upon a General Emergency event classification.



Source: GAO.

In 1978, a joint NRC and EPA task force issued guidance that provided a planning basis for off-site preparedness around commercial nuclear power plants<sup>8</sup> and, in this guidance, the agencies established two emergency planning zones. NRC defines emergency planning zones as areas for which planning is needed to ensure that prompt and effective actions can be taken to protect the public in the event of a radiological incident at a nuclear power plant.<sup>9</sup> In 1980, NRC and FEMA directed that this emergency planning zone guidance should be incorporated into emergency preparedness documents and planning. The 1978 guidance established the following two emergency planning zones:

- **10-Mile Plume Exposure Pathway Emergency Planning Zone.** According to the guidance, the principal health risks in this zone include direct exposure to radiation and inhalation exposure from the passing radioactive plume. For the plume exposure pathway, evacuation or shelter in place should be the primary protective actions. The radius for the emergency planning zone implies a circular area, but the actual shape can depend upon the characteristics of a particular site. For example, local authorities around the Limerick Generating Station in Pennsylvania told us that the Pennsylvania Turnpike was used as a boundary for part of the 10-mile zone. This road established a well-known landmark as a boundary that could be referenced when communicating instructions to the public about a radiological incident.

<sup>8</sup>NRC and EPA, *Planning Basis For the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants*, NUREG-0396/EPA 520/1-78-016 (Washington, D.C.: December 1978).

<sup>9</sup>NRC guidance uses the term "incident" instead of "accident" in discussing radiological planning and preparedness because an intentional hostile action directed at a nuclear site could become the direct cause of a radiological emergency.

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- **50-Mile Ingestion Exposure Pathway Emergency Planning Zone.** According to the guidance, the principal health risk in this zone is exposure from ingesting contaminated water or foodstuffs such as milk, fresh vegetables, or fish. In this pathway, health risks would come from longer term problems associated with contaminated food and water. Early actions to prevent contamination should include removing cows from pasture and putting them on stored feed.

According to NRC officials, the 10-mile and 50-mile emergency planning zones established in 1978 remain adequate, as indicated by recent NRC studies examining potential consequences at two nuclear power plants,<sup>10</sup> as well as public health impacts from the March 1979 incident at Three Mile Island in Pennsylvania and the 2011 Fukushima incident.

Protective actions are designed to decrease the time of exposure to radiation so that the benefits of the action offset any undesirable consequences, increase the distance from a radioactive source, provide shielding from the radiation plume, or limit ingestion of contaminated foodstuffs. Local and state authorities can implement a number of protective actions within the 10-mile emergency planning zone, including evacuating the public from areas that the projected plume is expected to cover, sheltering the public in homes or other structures, and providing potassium iodide to the public and emergency workers, if necessary, to provide some protection from an internal radiation exposure of radioactive iodine.<sup>11</sup> Further, for any given radiological incident, the same protective action may not necessarily be appropriate for all areas within the 10-mile zone. For example, the public in areas of the zone closest to the plant may be instructed to evacuate, while the public in other parts of the zone may be told to shelter in place. The appropriate protective action will

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<sup>10</sup>NRC, *State of the Art Reactor Consequence Analyses Project Volume 1: Peach Bottom Integrated Analysis*, NUREG/CR-7110 (Albuquerque, New Mexico: January 2012). The Peach Bottom Atomic Power Station is located in Peach Bottom Township, Pennsylvania. NRC, *State of the Art Reactor Consequence Analysis Project Volume 2: Surry Integrated Analysis* NUREG/CR-7110 (Albuquerque, New Mexico: January 2012). The Surry Power Station is located in Surry County, Virginia.

<sup>11</sup>According to NRC officials, the use of iodine to protect against the effects of radiation is recognized as an effective supplement to evacuation for situations involving radiation releases when evacuation cannot be implemented, or if exposure were to occur as a result of evacuation. Potassium iodide's usefulness as a protective measure is limited and only affords protection for the thyroid gland from an internal radiation exposure of radioactive iodine. It does not protect the body from radiation exposure or radiation dose.

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depend on a number of factors, including the projected beginning and duration of the radiological release, composition and direction of the release, weather conditions, and time of day. According to FEMA guidance, certain weather conditions, plume direction, or an event caused by a terrorist attack may pose an undue risk to evacuation and could make sheltering in place the preferred protective action.<sup>12</sup>

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## NRC and FEMA Framework for Radiological Emergency Preparedness

The incident at the Three Mile Island nuclear power plant near Middletown, Pennsylvania, on March 28, 1979, was the most serious in U.S. commercial nuclear power plant operating history, even though it led to no deaths or injuries to plant workers or members of the nearby community. In the incident, equipment malfunctions, design-related problems, and worker errors led to a partial meltdown of the core of one reactor and small off-site releases of radioactivity. Following the March 1979 incident, the White House transferred the federal lead role for off-site emergency planning and preparedness activities from NRC to FEMA<sup>13</sup> and, in 1980, NRC and FEMA entered into a memorandum of understanding to establish a framework of cooperation in matters of planning of radiological emergency preparedness.<sup>14</sup> This memorandum created a joint NRC and FEMA Steering Committee to implement and maintain these efforts. FEMA was directed to coordinate all federal planning for the off-site impact of radiological incidents and take the lead for assessing local and state authorities' radiological emergency response plans, make findings and determinations on the adequacy and capability of implementing off-site emergency plans, and communicate those findings and determinations to NRC. NRC agreed to review those FEMA findings and, in conjunction with NRC findings for licensees' emergency plans, determine the overall state of emergency preparedness. NRC uses these overall determinations to make radiological health and safety

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<sup>12</sup>FEMA, *Radiological Emergency Preparedness Program Manual* (April 2012).

<sup>13</sup>See 44 C.F.R. § 350.3(a) (2012), NRC and FEMA, Memorandum of Understanding Between NRC and FEMA To Accomplish a Prompt Improvement in Radiological Emergency Planning and Preparedness, 45 Fed. Reg. 5847 (Jan. 24, 1980) (referencing directive).

<sup>14</sup>44 C.F.R. pt. 353 app. A "Memorandum of Understanding Between Federal Emergency Management Agency and Nuclear Regulatory Commission." (2012) (codifying current memorandum of understanding, as last revised 2003).

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decisions when it issues licenses to nuclear power plants and during continuous monitoring of the overall state of radiological preparedness.

To manage its new responsibility for off-site emergency planning and preparedness in areas around commercial nuclear power plants, FEMA established the REP program. The REP program coordinates FEMA's effort to provide policies and guidance to local and state authorities to ensure that they have adequate capabilities to respond and recover from a radiological incident at a commercial nuclear power plant. The REP program has two funding sources: (1) a flat fee paid by licensees that is the same for each power plant and (2) variable fees paid by licensees to cover the cost of REP program activities associated with biennial exercises that each nuclear power plant and relevant local and state authorities must conduct every 2 years demonstrating the capabilities in their radiological emergency response plans. Local and state participation in off-site radiological emergency preparedness is voluntary, but participation in the program necessitates that local and state authorities adhere to the program's requirements set forth in federal regulations and guidance.<sup>15</sup> FEMA officials told us that all local and state governments that have a 10- or 50-mile commercial nuclear power plant emergency planning zone within their boundaries participate in the REP program. If local and state authorities opted not to participate in the REP program, licensees would have to demonstrate sufficient capabilities to fulfill off-site emergency response responsibilities.<sup>16</sup>

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#### NRC Task Force Established after Fukushima

In the aftermath of the Fukushima incident, NRC established the Near-Term Task Force in March 2011. The goal of the task force was to review NRC processes and regulations to determine whether additional improvements were needed to NRC's regulatory system and to make recommendations for these improvements. The task force review resulted in 12 recommendations to NRC, including 3 related to strengthening radiological emergency preparedness. For example, the task force observed gaps in public awareness in the United States following the incident at Fukushima. It recommended that, as part of a follow-on review, NRC should pursue emergency preparedness topics related to

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<sup>15</sup>44 C.F.R. pt. 350 (2012); FEMA, *Radiological Emergency Preparedness Program Manual*, (April 2012).

<sup>16</sup>10 C.F.R. 50.47 § (c)(1) (2012).



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decision making, radiation monitoring, and public education, particularly to increase education and outreach in the vicinity of each nuclear power plant in the areas of radiation, radiation safety, and the appropriate use of potassium iodide. With regard to the size of the emergency planning zones, NRC officials told us that the task force considered the existing planning structure, including the 10-mile plume exposure pathway and 50-mile ingestion exposure pathway emergency planning zones, and found no basis for recommending a change.<sup>17</sup>

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## NRC and FEMA Guide Licensees and Local and State Authorities in Radiological Emergency Preparedness

NRC and FEMA are responsible for guiding licensees and local and state authorities in radiological emergency preparedness. Specifically, NRC and FEMA's regulations and guidance establish the framework for on-site and off-site radiological emergency preparedness. Licensees manage preparedness on-site, and local and state authorities manage preparedness off-site.

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## NRC and FEMA's Regulations and Guidance Establish the Framework for On-site and Off-site Radiological Emergency Preparedness

NRC and FEMA's regulations for radiological emergency preparedness, originally issued in 1980 and 1983, respectively, are based upon 1980 guidance developed by a joint NRC and FEMA Steering Committee.<sup>18,19</sup> The regulations include 16 planning standards that nuclear power plants and local and state authorities are to address in their radiological emergency response plans. The standards require such actions as assigning responsibilities for the licensee and local and state authorities within the 10-mile emergency planning zone; establishing procedures on when and how the licensee is to notify local and state authorities and the public; developing a range of protective actions for emergency workers and the public within this emergency planning zone, such as evacuations or recommendations that the public remain indoors; and providing and maintaining adequate emergency facilities and equipment to support the emergency response. (App. I lists the 16 planning standards.) NRC and

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<sup>17</sup>NRC officials told us that the agency might consider a review of the basis for the emergency planning zone size in the future.

<sup>18</sup>10 C.F.R. § 50.47(b) (2012); 44 C.F.R. § 350.5 (b)(2012).

<sup>19</sup>NRC and FEMA, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*, NUREG-0654/FEMA-REP-1, Rev. 1 (Washington, D.C.: November 1980).

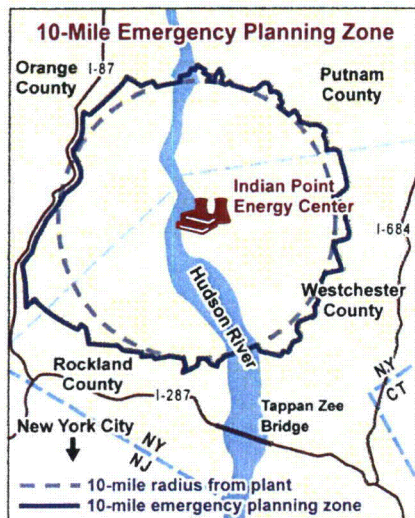
# Indian Point Energy Center – Buchanan, NY



Sources: GAO and Entergy Nuclear.

- **Population in 10-mile emergency planning zone:** 273,000
- **Location:** 24 miles N of New York City, NY
- **Generation:** Two reactors generate about 2,000 megawatts total, which is enough to power about 2 million homes, according to the licensee.
- **Licenses issued:** Unit 2 – 9/28/1973  
Unit 3 – 12/12/1975
- **Licenses' expiration:** Unit 2 – 9/28/2013  
Unit 3 – 12/12/2015

**Note:** This plant has the largest populations within both the 10-mile and 50-mile emergency planning zones in the country.



Source: GAO.

FEMA have published four supplements that support and expand on the 1980 guidance, including a 2011 supplement that provides guidance to (1) licensees on how to develop site-specific procedures for protective action recommendations and (2) local and state authorities on how to prepare for protective actions.<sup>20</sup> NRC and FEMA officials told us that they are in the early stages of developing new guidance to update the planning standards and associated guidance originally developed in 1980—an effort that they expect will take 4 to 5 years.

FEMA has issued guidance for local and state authorities that includes a 2012 update to the REP program manual, the principal source of policy and guidance relating to off-site radiological emergency preparedness. The manual interprets the planning standards established in 1980 and provides additional detail to local and state authorities on what FEMA expects them to include in their radiological emergency response plans. In addition, the manual provides criteria that FEMA uses to evaluate the ability of local and state governments to implement their emergency plans. Numerous FEMA and local officials we spoke with said that counties that participate in REP planning are much better prepared for other nonradiological emergencies, like hurricanes, because of the planning and exercises required by the REP program.

<sup>20</sup>NRC and FEMA, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants: Guidance for Protective Action Strategies*, NUREG-0654/FEMA-REP-1, Rev. 1 Supplement 3 (Washington, D.C.: November 2011).

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**Licensees Manage  
Emergency Preparedness  
On-site**

Licensees are responsible for managing on-site radiological emergency preparedness and developing and maintaining radiological emergency response plans that define specific actions and activities that the nuclear power plant must take to prepare for and respond to a potential incident at the plant. For example, according to the NRC regulations, the licensee must have met certain requirements, including the following:

- defined on-site emergency response staff responsibilities and maintained adequate staffing in key areas at all times,
- developed a standard emergency classification and action level scheme to help local and state authorities in determining initial off-site response measures,
- established notification procedures for the licensee to communicate emergency information to off-site local and state emergency organizations, and
- provided adequate methods and systems for assessing and monitoring actual or potential off-site consequences from a radiological incident.

Under the NRC regulations, the licensee is also responsible for recommending protective actions during a radiological incident generally to be implemented by the local and state authorities responsible for off-site radiological emergency preparedness—for example, recommending which communities should evacuate, and which should shelter in place—to minimize and/or avoid exposure to a radiological release. The licensee is to make these protective action recommendations based on specific plant conditions during the emergency, and the potential for, or actual amounts of, radiation being released into the atmosphere. For example, the representatives of the licensee at the San Onofre Nuclear Generating Station in San Clemente, California, told us that they consider wind direction, evacuation impediments, and information about how long the radiological release would occur and its projected dose when making protective action recommendations.

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**Local and State Authorities  
Manage Emergency  
Preparedness Off-site**

FEMA regulations and guidance apply where local and state authorities take responsibility for managing off-site radiological emergency preparedness efforts for the public near nuclear power plants. Specifically, local and state authorities develop radiological emergency response plans for their jurisdictions using the planning standards and



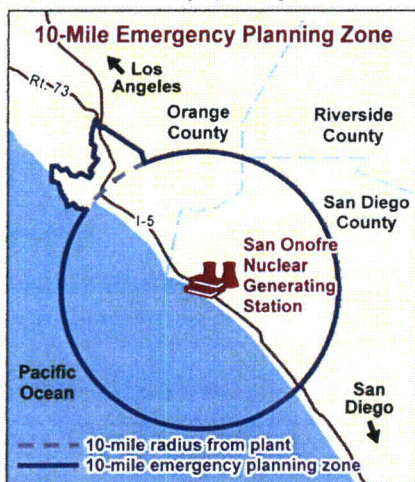
**San Onofre Nuclear Generating Station (SONGS) – San Clemente, CA**



Sources: GAO and Southern California Edison.

- **Population in 10-mile emergency planning zone:** 93,000
- **Location:** 46 miles SE of Long Beach, CA
- **Generation:** Two reactors generate about 2,200 megawatts total, which serve about 1.4 million homes and businesses when operating, according to the licensee.
- **Licenses issued:** Unit 2 – 2/16/1982  
Unit 3 – 11/15/1982
- **Licenses' expiration:** Unit 2 – 2/16/2022  
Unit 3 – 11/15/2022

**Note:** Not currently operating.



Source: GAO.

guidance detailed in the REP program manual. These off-site plans are to define specific actions and activities that local and state emergency response organizations should take to protect the public from a potential incident at the nearby nuclear power plant. For example, according to FEMA regulations and guidance, appropriate local and state organizations are to take a number of planning actions, including the following:

- identifying and assigning the principal roles, such as the responsibilities for the emergency management and law enforcement personnel who lead the emergency planning, preparedness, and response functions, and the support roles for federal agencies (e.g., FEMA) and volunteer organizations (e.g., the American Red Cross);
- coordinating classifications for different levels of emergencies and protective action strategies that are consistent with those established by the nearby nuclear power plant;
- establishing and describing the methods, both primary and backup, that are to be used to communicate between all local and state governments within the emergency planning zone and with the public; and
- establishing and describing an emergency operations center for use in directing and controlling response functions.

Differences in state laws and governing structures, as well as differences in FEMA's regional offices, can result in off-site emergency plans that meet FEMA regulations in different ways.<sup>21</sup> In some states, local officials lead off-site radiological emergency preparedness activities, with support from state emergency officials; in other states, radiological emergency preparedness activities are directed at a regional or state level. For example, the municipal, county, and school district jurisdictions near the Limerick Generating Station in Limerick, Pennsylvania, lead their own jurisdictions' activities for radiological emergency preparedness with state support, whereas the jurisdictions near the San Onofre Nuclear Generating Station in San Clemente, California, work together on a

<sup>21</sup>FEMA is composed of 10 regional offices that oversee FEMA activities. FEMA officials told us that regional REP offices have flexibility when interpreting FEMA guidance in order to reflect regional conditions.

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regional, interjurisdictional planning committee to jointly develop plans and policies and to decide on radiological emergency preparedness.

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## NRC and FEMA Oversee Radiological Emergency Preparedness by Reviewing Plans and Exercises

NRC and FEMA oversee licensees' and local and state authorities' radiological emergency preparedness, respectively, by reviewing emergency plans. The two agencies also oversee licensees and local and state authorities by assessing their respective capabilities during biennial emergency preparedness exercises. These oversight efforts are intended to provide reasonable assurance that adequate measures can and will be taken in the event of a radiological emergency.

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## NRC Reviews Licensees' Emergency Plans, and FEMA Evaluates Local and State Plans

Under its responsibilities to protect the radiological health and safety of the public, NRC must find that there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency before it issues an operating license for a nuclear power reactor.<sup>22</sup> NRC is to base its overall finding of reasonable assurance on (1) its assessment of the adequacy of a licensee's on-site emergency plans and (2) a review of FEMA findings about whether local and state off-site emergency plans are adequate and whether there is reasonable assurance they can be implemented.

## NRC Reviews

NRC bases its assessment of a licensee's emergency planning adequacy on its review of the licensee's plans to ensure that they meet the planning standards established in NRC regulations.<sup>23</sup> According to the memorandum of understanding between NRC and FEMA, once it grants an operating license, NRC maintains its finding of reasonable assurance by overseeing the licensee's on-site preparedness and communicating with FEMA about off-site preparedness. A licensee may make changes to its emergency plans without NRC approval if the licensee conducts and retains an analysis of the changes and its determination that the changes do not reduce the plan's effectiveness. If an emergency plan change is

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<sup>22</sup>NRC issues licenses for commercial nuclear power reactors to operate for 40 years. Under current regulations, licensees may renew their licenses for up to 20 years. Licensees seeking operating license renewal of reactors do not require a new finding of reasonable assurance.

<sup>23</sup>NRC officials told us that they also review license conditions for the facility.

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expected to result in a reduction in effectiveness, the licensee must provide the plan changes and supporting documentation to NRC for review and approval to ensure the plan continues to meet the required planning standards. For example, if an off-site fire department is identified and relied upon in the licensee's emergency plan, but is no longer able to respond to the site because of conflicting responsibilities assigned in local emergency plans, then the licensee must identify plan changes that ensure that the original capability exists in some form. To help maintain its finding of reasonable assurance on-site, NRC has established a reactor oversight process that describes the agency's program to inspect, measure, and assess the safety performance of commercial nuclear power plants and to respond to any decline in performance. One of the cornerstones of this process is emergency preparedness, and NRC measures the effectiveness of power plant staff in carrying out emergency plans and testing licensee emergency plans during biennial exercises. NRC's resident inspectors, who are permanently located at the plant, as well as inspectors from its regional offices, are to ensure that the licensee is effectively implementing and reviewing emergency preparedness, according to NRC's reactor oversight process.

As part of the licensing process, NRC also requires nuclear power plants to develop studies of estimated evacuation times in order to identify potential challenges to efficient evacuation in the event of a nuclear power plant incident. These studies are to include an analysis of the time required to evacuate different portions of a nuclear power plant's 10-mile planning zone.<sup>24</sup> Licensees are to (1) use these evacuation time estimates in formulating protective action recommendations and (2) provide the estimates to local and state authorities for use in developing off-site protective action strategies. To account for demographic changes around commercial nuclear power plants, NRC revised regulations, effective December 2011, to require that these evacuation time estimates be updated (1) after every decennial census and (2) any time an increase in the permanent population results in an evacuation time increase of 25 percent or 30 minutes, whichever is less for one of the potential evacuation areas. In addition, 2011 NRC guidance directs that evacuation time estimates include a consideration of shadow evacuations, defined as an evacuation of the public in areas outside an officially declared

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<sup>24</sup>10 C.F.R. pt. 50 app. E (IV) (2012).



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evacuation area.<sup>25</sup> Specifically, the guidance states that these evacuation time estimate studies should include a shadow evacuation consideration of 20 percent of the population out to 15 miles away from the nuclear power plant. In addition, NRC guidance states that the shadow population consideration is to account for the extent to which this population's evacuation would impede the evacuation of those under evacuation orders.

## FEMA Reviews

As stated above, NRC considers FEMA's reviews of each local and state authority's emergency plan for off-site preparedness during the initial licensing process. In reviewing these plans, FEMA uses the planning standards and evaluation criteria collectively identified in its regulations and guidance to determine whether these off-site plans are adequate to protect public health and safety by providing reasonable assurance that appropriate protective measures can be taken off-site in the event of a radiological emergency. In addition, the local and state authorities must participate in an initial full-scale exercise with the licensee.<sup>26</sup> FEMA approves the authorities' plans as being adequate if the plans and the exercise provide reasonable assurance that the plans are adequate and can be implemented.<sup>27</sup> FEMA then communicates this approval or disapproval to the state and to NRC for consideration in the licensing process.

After the initial FEMA finding that the off-site emergency plans and their capabilities provide reasonable assurance about off-site radiological emergency preparedness, FEMA relies on a combination of other activities to ensure that local and state authorities maintain this reasonable assurance. In particular, FEMA relies on the following:

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<sup>25</sup>NRC, *Criteria for Development of Evacuation Time Estimate Studies*, NUREG/CR-7002 (Albuquerque, New Mexico: November 2011).

<sup>26</sup>To support the initial licensing process, the licensee and local and state authorities must conduct a full-scale exercise. According to FEMA guidance, the full-scale exercise should include all response organizations that would be involved in a response to an incident at the plant, but subsequent biennial exercises may not need to include all response organizations.

<sup>27</sup>A public meeting must also be held near the power plant to, among other things, acquaint the public with the plans and answer questions about FEMA's review of the plan and the exercise.

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- *Biennial exercises.* Each nuclear power plant and its relevant local and state authorities must conduct an exercise every 2 years that demonstrates their abilities to implement their respective emergency plans.<sup>28</sup> Local and state authorities that participate in the biennial exercises submit their emergency plans to FEMA staff before the exercises, and FEMA evaluators review the plans and assess off-site performance based on the activities identified in those plans.
  - *Annual letter of certification.* To help FEMA determine whether local and state authorities' plans and implementation activities provide reasonable assurance about off-site radiological preparedness, states that participate in the REP program annually submit a letter of certification to FEMA providing assurance that all required activities have been undertaken as appropriate by local and state authorities. Among other things, the state is asked to certify that the plans have been reviewed for accuracy and completeness and provide documentation that supports off-site planning, such as the information that authorities are required to provide annually to those in the 10-mile emergency planning zone (e.g., establishing classifications for different levels of emergencies and protective action instructions)
  - *Staff assistance visits.* FEMA assigns a representative to serve as the primary advisor for the local and state authorities near each nuclear power plant, and the FEMA representatives are to visit local and state authorities to answer questions and assist in planning and exercise preparation. Local authorities near the Limerick Generating Station in Limerick, Pennsylvania, told us that they are in contact with FEMA representatives several times a month, including during site assistance visits, and feel they have a well-established relationship with FEMA.

FEMA may also review off-site emergency preparedness following events such as electric grid blackouts, intentional harm, or natural disasters in the vicinity of commercial nuclear power plants, which can result in infrastructure damage that can degrade the capabilities of local and state authorities to respond to a radiological incident. For example, natural disasters that destroy roads or bridges around a plant could affect the

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<sup>28</sup>Licensees and local and state authorities told us they conduct other drills and exercises throughout the year to train emergency response staff and ensure emergency preparedness is adequate.

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ability of local and state authorities to effectively conduct evacuations. According to the memorandum of understanding between NRC and FEMA, FEMA is to (1) inform NRC promptly if FEMA questions the continued adequacy of off-site emergency preparedness, (2) review off-site radiological emergency preparedness if it believes that a review is necessary to determine whether off-site preparedness remains adequate, and (3) inform NRC in writing about the results of its review. NRC is to consider the information FEMA provides, in addition to its assessment of the licensee's facility, in deciding to allow the restart or continued operation of an affected operating nuclear power plant. For example, after Hurricane Katrina in 2005, the Waterford Nuclear Generating Station in Killona, Louisiana, was shut down for about 2 weeks. FEMA conducted a review of local and state authorities' ability to respond to a radiological incident and concluded that off-site radiological preparedness was adequate to justify restarting the plant.

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### NRC and FEMA Oversee and Evaluate Radiological Emergency Preparedness Exercises

NRC and FEMA also oversee radiological emergency preparedness by reviewing the biennial exercises conducted by licensees and local and state authorities.<sup>29</sup> According to NRC and FEMA guidance, these exercises simulate incidents at nuclear power plants that require coordination between licensees, local and state authorities, and federal entities, and provide the opportunity for NRC and FEMA officials to evaluate the emergency plans in action. According to NRC guidance, NRC's inspectors are to observe these biennial exercises to evaluate the adequacy of the licensee's performance, including the operation of the alert and notification system and the individual performance of the emergency response staff.<sup>30</sup> In addition, NRC inspectors are to evaluate the licensee's ability to assess and critique its own performance to identify and correct weaknesses observed during the exercise. For example, one NRC inspector told us that he observes how the licensee responds to an escalation of events, prepares and issues protective action recommendations, and makes assessments of radiological doses during an exercise. The inspector also said that he observes whether the

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<sup>29</sup>According to FEMA and NRC officials, these exercises are usually conducted simultaneously, but simultaneous exercises are not required. NRC officials told us that this flexibility is provided to address circumstances in which there are multiple commercial nuclear power plant sites within a state, or two licensees on the same site.

<sup>30</sup>Licensees are required by the planning standards to have procedures to notify local and state authorities and emergency personnel.

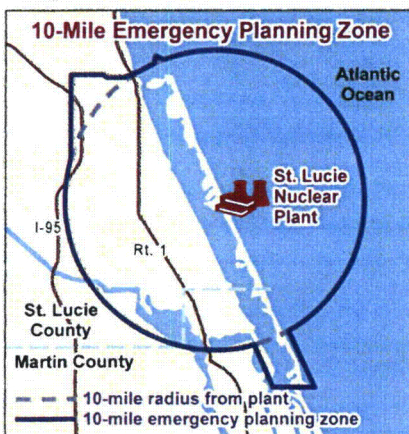
**St. Lucie Nuclear Power Plant – Jensen Beach, FL**



Sources: GAO and Florida Power & Light.

- **Population in 10-mile emergency planning zone:** 207,000
- **Location:** 10 miles SE of Fort Pierce, FL
- **Generation:** Two reactors generate about 1,700 megawatts total, which is enough to supply the annual needs of more than 500,000 homes, according to the licensee.
- **Licenses issued:** Unit 1 – 3/01/1976  
Unit 2 – 6/10/1983
- **Licenses' expiration:** Unit 1 – 3/01/2036  
Unit 2 – 4/06/2043

**Note:** This plant has the fifth largest population within the 10-mile emergency planning zone of all U.S. commercial nuclear power plants, as well as one of the highest population growth rates over the last 10 years.



Source: GAO

licensee is able to identify its own performance problems and then takes the necessary corrective actions.

With respect to off-site evaluation, under agency guidance, FEMA evaluators are to observe the conduct of local and state authorities and write detailed after-action reports that identify planning and performance problems, if any. FEMA is also to work with the local and state authorities to develop an improvement plan that contains information on how the authorities will improve performance or correct problems identified in the after-action report, the personnel responsible for specific actions, and an anticipated timeline for improvement or correction. Local and state authorities are expected to correct the problem or redemonstrate a capability within a specified time frame.<sup>31</sup> If the local and state authorities do not address the problems, FEMA officials told us that they would notify NRC that off-site preparedness was insufficient to protect public health and safety. Furthermore, NRC officials told us that they could require the plant to shut down until the off-site problems were addressed but that they have never required such a shutdown.

Licensees develop exercise scenarios ahead of biennial exercises with input from local and state authorities to provide the maximum training opportunities for all the entities involved.<sup>32</sup> However, those who participate in the exercises, including power plant staff, do not know about the contents of the exercise scenario beforehand. In addition, an official with one local authority near the St. Lucie Nuclear Power Plant told us that they have injected certain incidents into an ongoing exercise, such as a disabled truck on a freeway, to test elements of their emergency plans that may not otherwise be included in the initial scenario. Exercises begin when an initiating event is simulated at the nuclear power plant in accordance with the scenario the licensee developed. Plants must be able to assess, classify, and declare an emergency condition within 15 minutes after plant operators have information indicating that an emergency condition exists. Plants are then to provide local and state authorities with an emergency classification level that identifies the severity of the event and the actions that could be taken. The

<sup>31</sup>The time frames vary depending on the type of problem identified and the steps taken, if any, to address them.

<sup>32</sup>FEMA officials told us that FEMA and NRC also participate in some aspects of scenario development.

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classification levels are considered trigger points for surrounding authorities, so that when a certain level is set, a series of actions must be performed. The classification levels are the following:

- Notification of unusual event—a potential degradation of safety or indication of a security threat that involves no expected release of radiation unless further degradation occurs.
- Alert—an actual or potential substantial degradation of safety at the plant or a security event that involves probable life threatening risk to site personnel or damage to site equipment, and any release is expected to be limited to small fractions of EPA protective action guide exposure levels.<sup>33</sup>
- Site area emergency—an actual or likely major failure of plant protection equipment that protects the public or a security event that could lead to the likely failure of or prevents access to plant protection equipment. Any radiation releases are not expected to exceed exposure levels from the EPA protective action guides beyond the site boundary. A site area emergency may, for example, trigger precautionary evacuations of schools and parks.
- General emergency—an actual or imminent substantial core degradation or melting with the potential for loss of containment of radiation or security events that result in an actual loss of physical control of the facility, with radiation releases reasonably expected to exceed EPA protective action guide exposure levels off-site for more than the immediate area. The Three Mile Island incident is the sole general emergency ever to have occurred in the United States. Since the Three Mile Island incident, in Pennsylvania, it is state policy to conduct a single protective action for the full 10-mile emergency planning zone whenever a general emergency at a nuclear power plant in the state is declared.

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<sup>33</sup>EPA developed a *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* in 1980 to help local and state authorities determine when to take protective actions in response to an airborne plume during the early phase of an incident at a nuclear power plant. A protective action guide represents the projected radiation dose to individuals that triggers the need for protective actions from a release of radioactive material. EPA officials told us that protective action guides do not imply acceptable levels of risk or a boundary between safe and unsafe conditions, but they represent the approximate radiation levels at which certain protective actions are justified.

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If the situation on-site reaches a level where local and state authorities should consider taking protective actions, the licensee is to recommend the protective actions that off-site authorities should take. The authority responsible for decision making is to take the licensee's recommendation into consideration, together with other considerations, such as radiological dose assessment readings. We noted that local and state authorities near the four power plants we visited have dose assessment teams that are to take radiation readings in the area during an incident and coordinate radiation readings with licensee dose assessment teams to help assess the situation and to help with overall decision making. In some states, the local counties and cities have the primary role in making protective action decisions. For example, around the St. Lucie Nuclear Power Plant in Florida, county officials for several counties told us that they develop individual emergency plans, but they work together during an emergency to coordinate the appropriate protective action decision for the area. According to local and state authorities around the San Onofre Nuclear Generating Station in California, two counties, three cities, one U.S. Marine Corps base, the California Department of Parks and Recreation, and the power plant licensee formed an interjurisdictional planning committee to coordinate an emergency plan for the area. Members of this committee collectively decide on the protective action to take during an incident, based on the licensee's protective action recommendation.

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**NRC and FEMA  
Require That the  
Public within the 10-  
Mile Zone Be  
Informed Annually  
about Preparedness,  
but NRC Has Little  
Information about  
Public Awareness  
Outside This Zone**

NRC and FEMA require licensees and local and state authorities to provide emergency preparedness information annually to the public within the 10-mile emergency planning zone, and NRC has studied public awareness within the zone. A 2008 NRC study found that the public within the 10-mile zone is generally aware of emergency preparedness and likely to follow instructions, but NRC has not studied likely responses to an incident outside this zone. Without knowing reactions outside the 10-mile zone, NRC cannot be confident that its estimates of shadow evacuations outside the 10-mile zone provide a reasonable basis for planning off-site protective action strategies.



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**NRC and FEMA Require Licensees and Local and State Authorities to Provide Detailed Information Annually to the Public within the 10-Mile Planning Zone**

NRC and FEMA's regulations and guidance establish the framework for how licensees and local and state authorities are to inform the public about how to respond during a radiological emergency and provide educational information about radiation. Specifically, NRC regulations require that licensees annually provide basic emergency planning information to the public within the 10-mile emergency planning zone. This information may take various forms, including brochures, telephone book inserts, or calendars. According to NRC and FEMA guidance, these materials must include educational information on radiation, protective measure information such as evacuation routes and relocation centers, information relating to the special needs of the handicapped, and a contact for additional information. FEMA guidance also states that the content of these materials is generally determined through coordination between local and state authorities and the licensees. For example, St. Lucie County authorities in Florida told us that they develop the annual mailing in cooperation with neighboring Martin County authorities, so that both counties use the same materials, and then the licensee prints and distributes this mailing to households and businesses within the 10-mile emergency planning zone around the nuclear power plant in St. Lucie, Florida. Licensees told us that they translate these materials into non-English languages and make them available to the public, depending on the demographic makeup of their communities, as directed by FEMA guidance. NRC and FEMA updated their guidance on these public information programs in November 2011 to provide more information about protective actions in public information materials. For example, the 2011 guidance recommends that local and state authorities explain the purpose of staged evacuations, define expectations for those under an advisory, clarify expectations for those who are not at home when a protective action is ordered, and discourage parents from picking up their children from school during an event. Staged evacuation occurs when the population in one area is evacuated, while the population in another area is told to remain indoors until it is their turn to evacuate. According to NRC guidance, the success of staged evacuation depends on public compliance with sheltering in place while the population most at risk is evacuated. NRC's research on the matter has suggested that the public requires clear and direct communication both to evacuees and to those near, but not within, affected areas.

FEMA guidance also instructs local and state authorities to conduct outreach to certain special needs populations within the 10-mile emergency planning zone. Specifically, FEMA's guidance instructs licensees and local and state authorities to take the following actions:

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- *Conduct outreach to transient populations.* Authorities may, for example, issue pamphlets, stickers, or signs in hotels, motels, and public parks. Local and state authorities in communities around San Onofre Nuclear Generating Station near San Clemente, California, told us that they provide a card to campers when they enter state parks that tells them what to do and which radio stations to tune into in the event of an emergency at the nuclear power plant; are working with hotels to include emergency information in each hotel room; and have trained hotel managers and staff to make sure they are registered with the appropriate jurisdiction to receive emergency alerts.
  - *Have a plan to identify individuals who need assistance when evacuating.* Some local and state authorities told us that they accomplish this by including a card inside the annual mailing that enables residents with special needs to identify their needs and complete and mail back the card to the licensee or to their local authorities, so that the authorities can track special needs individuals during an emergency.

FEMA guidance also instructs local and state authorities to establish coordinated arrangements for dealing with rumors and unconfirmed reports to provide the public with direct access to accurate information during an incident, as well as to provide local and state authorities with information about trends in public inquiries. For example, some local and state authorities told us that they have established dedicated public information telephone numbers and assigned staff to answer questions in the event of an incident. Local and state authorities we spoke with varied in their use of social media forums to monitor and respond to rumors before or during an incident. Some local and state authorities near the four plants we visited said that they use social media to provide preparedness information, while others said they do not use social media. FEMA officials told us that they are currently studying different social media technologies and how information is disseminated to the public. In addition, local and state authorities are required to conduct annual efforts to brief news media on emergency plans, radiation information, and their points of contact in an emergency. State of Florida authorities go beyond these requirements and told us they conduct two media briefings annually, hold an annual press conference with the Lieutenant Governor, and provide radiological emergency preparedness information sheets to the press.

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Local and state authorities we spoke with told us that they conduct other voluntary activities to inform the public in the 10-mile emergency planning zone. These activities include informing residents about annual siren testing required in the zone, conducting presentations to community groups and at local events, providing information to parents at schools, and posting information on websites. Authorities we spoke with said that some of these voluntary activities may also occur outside the 10-mile emergency planning zone.

NRC and FEMA do not require public information efforts for radiological emergency preparedness outside the 10-mile emergency planning zone. According to NRC and FEMA guidance, for the worst incidents at commercial nuclear power plants, immediate life-threatening radiation doses would generally not occur outside the 10-mile zone and would probably not require protective actions outside the zone.<sup>34</sup> In the 50-mile emergency planning zone, the principal exposure to radiation would be ingestion of contaminated food and water, and this would represent a longer term problem. According to FEMA guidance, the licensee and state authorities are to make information available to farmers and other members of the agricultural industry within the 50-mile emergency planning zone. This information is to describe recommended protective actions for agricultural industries to minimize contamination of the food supply. Some state and local authorities told us that they sometimes conduct public education efforts outside of the 10-mile zone that include radiological emergency preparedness information. However, some authorities also expressed concerns about the radiological awareness levels of residents and the potential for shadow evacuations. For example, Los Angeles County authorities told us that one of their greatest concerns in the event of an incident at the San Onofre Nuclear Generating Station is a rumor that results in shadow evacuations, which could result in clogged highways as people who are not in danger choose to evacuate unnecessarily.

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<sup>34</sup>NRC and FEMA, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*, NUREG-0654/FEMA-REP-1, Rev. 1 (Washington, D.C.: November 1980).

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**NRC Has Studied  
Awareness and Likely  
Responses to an Incident  
Inside the 10-Mile  
Emergency Planning Zone  
but Not Outside of It**

In 2008, NRC conducted a study with the Sandia National Laboratory to examine public awareness of emergency preparedness information and likely responses within the 10-mile emergency planning zone. The laboratory administered a national telephone survey to random members of households within each of the 63 10-mile emergency planning zones.<sup>35</sup> According to the study results, those surveyed were generally well-informed, with many having taken action to prepare for an emergency. Furthermore, most of those who responded to the survey reported that they believe they are likely to follow directions from local and state authorities in the event of an incident at the nuclear power plant.<sup>36</sup> However, about 20 percent of those responding to the survey reported that they would evacuate even when told evacuation for them was not necessary, referred to as a shadow evacuation. NRC guidance states that a shadow evacuation can impede the evacuation of those under evacuation orders. Also, most of those who responded to the survey and who have children in school reported that they were likely to pick up their children from school in an emergency. Using the findings from this study, NRC updated guidance on protective action strategies and improving public information programs in November 2011.<sup>37</sup> This guidance recommends that local and state authorities provide more information about the purpose of staged evacuations, in addition to simply describing the different types of protective action strategies.

To address the potential for shadow evacuations, NRC officials told us that they used the study results to determine the potential shadow evacuation rate outside the 10-mile emergency planning zone. Specifically, NRC instructed licensees to consider shadow evacuations of 20 percent of the public out to 15 miles from the nuclear power plant

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<sup>35</sup>There are currently 65 nuclear power plants in the United States; however, some nuclear power plants are located on the same site and therefore have the same emergency planning zone.

<sup>36</sup>Estimates for this survey have 95 percent confidence intervals within plus or minus 3.5 percentage points unless otherwise noted.

<sup>37</sup>NRC and FEMA, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants: Guidance for Protective Action Strategies*, NUREG-0654/FEMA-REP-1, Rev. 1 Supplement 3 (Washington, D.C.: November 2011).

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when the licensee develops estimates of evacuation times.<sup>38</sup> However, the study surveyed residents inside the 10-mile emergency planning zone, a population that is given radiological emergency preparedness information every year and that is therefore more familiar with the power plant, radiation risks, protective actions, and evacuation routes than the public outside the 10-mile zone.<sup>39</sup> Without this same level of information, those outside the zone may not respond in a similar manner to a radiological incident as those inside the zone. Because the survey was conducted on a relatively more educated and aware population, the 20-percent rate for shadow evacuations may not accurately capture the level of shadow evacuations that may occur outside the 10-mile zone. According to NRC and FEMA officials, their agencies have not examined public awareness outside the 10-mile emergency planning zone and therefore do not know if a 20-percent estimate of shadow evacuations is reasonable. Therefore, licensee evacuation time estimates may not accurately consider the impact of shadow evacuations. Without estimates of evacuation times based on more solid understanding of public awareness outside the 10-mile zone, licensees and NRC and FEMA cannot be confident about the reliability of their estimates. If shadow evacuations are not correctly estimated, planning for a radiological emergency may not sufficiently consider the impact of the public outside the 10-mile emergency planning zone. Shadow evacuations outside this zone greater than the assumed 20-percent rate would put additional traffic on roadways, possibly delaying the evacuation of the public inside the emergency planning zone and potentially increasing the risk to public health and safety.

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## Conclusions

The Fukushima Daiichi incident raised questions about the U.S. government's ability to protect its citizens if a similar incident were to occur here. NRC and FEMA have developed regulations and guidance to help licensees and local and state authorities create and test radiological emergency response plans that are intended to provide reasonable assurance that they can adequately protect public health and safety in the

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<sup>38</sup>NRC, *Criteria for Development of Evacuation Time Estimate Studies*, NUREG/CR-7002 (Albuquerque, New Mexico: November 2011). This guidance did not include instructions for shadow evacuation estimates for the area beyond 15 miles.

<sup>39</sup>Some local authorities we spoke with said that they had also conducted surveys on preparedness for all types of emergencies, and some of these studies asked questions on radiological emergency awareness and likely reactions of the public.

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event of a radiological incident at a nuclear power plant. NRC regulations and guidance also direct licensees to annually provide emergency preparedness information to the public within their 10-mile emergency planning zones. Furthermore, the 2008 NRC study by Sandia National Laboratory demonstrated that the public within these planning zones is generally likely to respond to instructions from local and state authorities in the event of an incident. On the basis of this study, NRC estimated that 20 percent of the public within the zones would choose to evacuate even when told evacuation for them was not necessary (shadow evacuations). NRC then directed licensees to consider this same percentage of shadow evacuations for the public outside the planning zone when estimating evacuation times. However, communities outside the 10-mile zone generally do not receive the same level of information as those within the 10-mile zone and therefore may not be as knowledgeable about appropriate conduct during a radiological emergency as those inside the zone and may not respond in a similar manner. If the public outside the zone evacuates unnecessarily at a greater rate than expected, these shadow evacuations would put additional traffic on roadways, possibly delaying the evacuation of the public inside the emergency planning zone and potentially increasing the risk to public health and safety. However, because neither NRC nor FEMA have examined public awareness outside of the 10-mile emergency planning zone, they do not know how the public outside this zone will respond. Specifically, they do not know if a 20-percent estimate of shadow evacuations is reasonable. Therefore, licensee evacuation time estimates may not accurately consider the impact of shadow evacuations. Without estimates of evacuation times based on more solid understanding of public awareness, licensees and NRC and FEMA cannot be confident about the reliability of their estimates. If shadow evacuations are not correctly estimated, planning for a radiological emergency may not sufficiently consider the impact of the public outside the emergency planning zone.

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## Recommendation for Executive Action

To better inform efforts for nuclear power plant emergency preparedness and planning, we recommend that NRC Commissioners obtain information on public awareness of radiological emergency preparedness for communities outside the 10-mile emergency planning zone and the likely response of those communities in the event of a radiological incident at a nuclear facility and consider how these results may affect estimates for shadow evacuations outside the zone.



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## Agency Comments and Our Evaluation

We provided a draft of this report to the NRC Commissioners and the Secretary of the Department of Homeland Security for their review and comment. DHS provided no written comments. NRC provided written comments on the draft report, which are reproduced in appendix II, and technical comments from NRC, which we incorporated into the report as appropriate.

NRC found our discussion of emergency preparedness programs at nuclear power plants to be complete, but generally disagreed with our finding on shadow evacuations. Specifically, NRC did not believe that the report accurately captured the technical basis for the NRC's use of 20 percent as a reasonable estimate of shadow evacuations beyond 10 miles. NRC explained that it has conducted considerable research on evacuations and has confidence that shadow evacuations generally have no significant impact on traffic movement. Lastly, NRC stated that the licensee's current emergency planning bases continue to provide reasonable assurance of protection of the public's health and safety.

We stand by our finding and the related recommendation that NRC should obtain information on public awareness and the likely responses of communities outside the 10-mile zone in the event of a radiological incident at a nuclear power plant.

First, as stated in the report, NRC issued guidance in 2011 that directs licensees to consider shadow evacuations of 20 percent of the population located from 10 miles to 15 miles from a nuclear plant when estimating evacuation times.<sup>40</sup> NRC told us that this shadow evacuation estimate came primarily from a telephone survey it conducted of the public within each of the 63 10-mile emergency planning zones around the country. However, residents inside the 10-mile zone are provided radiological information every year and are therefore more familiar with the power plant, radiation risks, protective actions, and evacuation routes than those outside the zone. Without this same level of information, residents outside the zone may not respond in a similar manner as those inside the zone, and the use of a 20 percent shadow evacuation estimate for the public outside the zone may therefore not be reliable.

Second, NRC asserts that it has conducted considerable research on evacuations and has confidence that shadow evacuations generally have

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<sup>40</sup>NRC, *Criteria for Development of Evacuation Time Estimate Studies*, NUREG/CR-7002 (Albuquerque, New Mexico: November 2011).

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no significant impact on traffic movement. GAO acknowledges that NRC has conducted research on evacuations, but these studies are generally based on evacuations that have resulted from non-nuclear incidents such as hurricanes, wildfires, and chemical spills. It is unclear whether the public would behave the same for a nuclear evacuation as it would for the incidents that NRC has studied. As we say in the report, NRC's Near-Term Task Force established after the Fukushima incident observed gaps in public awareness in the United States. The task force recommended that, as part of a follow-on review, NRC should pursue emergency preparedness topics related to decision-making, radiation monitoring, and public education, particularly to increase education and outreach in the vicinity of each nuclear power plant in the areas of radiation, radiation safety, and the appropriate use of potassium iodide. We believe the task force's finding that there are gaps in public awareness and understanding regarding nuclear incidents supports our recommendation that NRC should obtain information on public awareness and the likely responses of communities outside the 10-mile zone in the event of a radiological incident at a nuclear power plant.

Finally, with regard to NRC's confidence that shadow evacuations generally have no significant impact on traffic movement, according to NRC's 2011 guidance mentioned earlier, evacuation time estimate studies should include a shadow evacuation consideration of 20 percent of the population out to 15 miles away from the nuclear power plant because the additional traffic generated has the potential to impede an evacuation of the emergency planning zone. Thus, NRC has previously acknowledged in its guidance that traffic from shadow evacuations may impede the intended evacuations. For these reasons, we believe our recommendation to improve NRC's understanding of the effect of shadow evacuations outside of the 10-mile zone is consistent with NRC's guidance about the potential effects of shadow evacuations on evacuations within the emergency planning zone.

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As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the Chairman of the NRC, the Secretary of the Department of Homeland Security, the appropriate congressional committees, and other interested parties. In addition, this report will be available at no charge on the GAO website at <http://www.gao.gov>.

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If you or your staff members have any questions about this report, please contact Frank Rusco at (202) 512-3841 or [ruscof@gao.gov](mailto:ruscof@gao.gov) or Stephen Caldwell at (202) 512-9610 or [caldwells@gao.gov](mailto:caldwells@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.



Frank Rusco  
Director, Natural Resources and Environment



Stephen L. Caldwell  
Director, Homeland Security and Justice

# Appendix I: NRC and FEMA Planning Standards

NRC and FEMA Planning Standards		
1	Assignment Of Responsibility (Organization Control)	Primary responsibilities for emergency response by the nuclear facility licensee and by state and local organizations within the emergency planning zones have been assigned, the emergency responsibilities of the various supporting organizations have been specifically established, and each principal response organization has staff to respond and to augment its initial response on a continuous basis.
2	On-site Emergency Organization	On-duty facility licensee responsibilities for emergency response are unambiguously defined, adequate staffing to provide initial facility accident response in key functional areas is maintained at all times, timely augmentation of response capabilities is available, and the interfaces among various on-site response activities and off-site support and response activities are specified.
3	Emergency Response Support and Resources	Arrangements for requesting and effectively using assistance resources have been made, arrangements to accommodate state and local staff at the licensee's emergency operations facility have been made, and other organizations capable of augmenting the planned response have been identified.
4	Emergency Classification System	A standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and state and local response plans call for reliance on information provided by facility licensees for determinations of minimum initial off-site response measures.
5	Notification Methods and Procedures	Procedures have been established for notification, by the licensee, of state and local response organizations and for notification of emergency personnel by all organizations; the content of initial and follow up messages to response organizations and the public has been established; and means to provide early notification and clear instruction to the populace within the plume exposure pathway emergency planning zone have been established.
6	Emergency Communications	Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.
7	Public Education and Information	Information is made available to the public on a periodic basis on how they will be notified and what their initial actions should be in an emergency (e.g., listening to a local broadcast station and remaining indoors), the principal points of contact with the news media for dissemination of information during an emergency (including the physical location or locations) are established in advance, and procedures for coordinated dissemination of information to the public are established.
8	Emergency Facilities and Equipment	Adequate emergency facilities and equipment to support the emergency response are provided and maintained.
9	Accident Assessment	Adequate methods, systems, and equipment for assessing and monitoring actual or potential off-site consequences of a radiological emergency condition are in use.
10	Protective Response	A range of protective actions has been developed for the plume exposure pathway emergency planning zone for emergency workers and the public. Guidelines for the choice of protective actions during an emergency, consistent with federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway emergency planning zone appropriate to the locale have been developed.

**Appendix I: NRC and FEMA Planning Standards**

<b>NRC and FEMA Planning Standards</b>		
11	Radiological Exposure Control	Means for controlling radiological exposures, in an emergency, are established for emergency workers. The means for controlling radiological exposures shall include exposure guidelines consistent with EPA emergency worker and lifesaving activity protective action guides.
12	Medical and Public Health Support	Arrangements are made for medical services for contaminated injured individuals.
13	Recovery and Reentry Planning and Post-Accident Operations	General plans for recovery and reentry are developed.
14	Exercises and Drills	Periodic exercises are (will be) conducted to evaluate major portions of emergency response capabilities, periodic drills are (will be) conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills are (will be) corrected.
15	Radiological Emergency Response Training	Radiological emergency response training is provided to those who may be called on to assist in an emergency.
16	Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans	Responsibilities for plan development and review and for distribution of emergency plans are established, and planners are properly trained.

Sources: NRC and FEMA, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654/FEMA-REP-1, Rev. 1 (Washington, D.C.: November 1980).

# Appendix II: Comments from the Nuclear Regulatory Commission



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0301

February 11, 2013

Mr. Franklin Rusco, Director  
Natural Resources and Environment  
U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548

Dear Mr. Rusco:

Thank you for providing the U.S. Nuclear Regulatory Commission (NRC) the opportunity to review and comment on the U.S. Government Accountability Office's (GAO's) draft report GAO-13-243, "Emergency Preparedness: NRC Needs to Better Understand Likely Public Response to Radiological Incidents." The NRC staff reviewed the draft report and found the discussion on the emergency preparedness programs at nuclear power plants to be complete. However, the NRC staff does not believe that the report accurately captured the technical basis for the NRC's use of 20 percent as a reasonable estimate of shadow evacuation in the population beyond 10 miles. The NRC staff has conducted considerable research into evacuations, including the impact of shadow evacuations on evacuation outcomes. Based on this research, NRC has confidence that shadow evacuations generally have no significant impact on traffic movement, and concludes that the licensee's current emergency planning bases continue to provide reasonable assurance of protection of the public's health and safety. The NRC staff has provided its technical basis for shadow evacuations in the enclosure to this letter along with a few additional comments.

If you have any questions regarding this response, please contact Jesse Arildsen. Mr. Arildsen can be reached by telephone at (301) 415-1785.

Sincerely,

A handwritten signature in dark ink, appearing to read "R. W. Borchardt".

R. W. Borchardt  
Executive Director  
for Operations

Enclosure:  
U.S. Nuclear Regulatory Commission  
Staff Comments

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# Appendix III: GAO Contacts and Staff Acknowledgments

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## GAO Contacts

Frank Rusco, (202) 512-3841 or [ruscof@gao.gov](mailto:ruscof@gao.gov)  
Stephen Caldwell, (202) 512-9610 or [caldwells@gao.gov](mailto:caldwells@gao.gov)

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## Staff Acknowledgments

In addition to the individuals named above, Kimberly Gianopoulos, Assistant Director; Nathan Gottfried; Eugene Gray; David Lysy; and David Messman made key contributions to this report. Important contributions were also made by Elizabeth Beardsley, Marcia Crosse, R. Scott Fletcher, Jonathan Kucskar, Steven Putansu, Dan Royer, Carol Shulman, and Kiki Theodoropoulos.

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