U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

BACKGROUNDER
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Emergency Preparedness at Nuclear Power Plants

Background

The Nuclear Regulatory Commission (NRC) reexamined the role of emergency preparedness (EP) for protecting the public near nuclear power plants following the accident at the Three Mile Island nuclear power plant in 1979. The accident showed the need for improved planning, response, and communication by federal, state, and local governments to deal with reactor accidents. Although the NRC remained vigilant over the years, the events of September 11, 2001, prompted a new focus on emergency preparedness and a further review of the threat environment. The NRC now considers new threat scenarios and protections in emergency preparedness in light of the threat of terrorist attacks.

Nuclear power plant owners, government agencies, State and local officials, as well as thousands of volunteers and first responders have worked together for more than 20 years to create a system of emergency preparedness and response that will serve the public well in the unlikely event of an emergency. The nuclear power plants' emergency plans include preparations for evacuation, sheltering, or other actions to protect the residents near nuclear power plants in the event of a serious incident.

Since commercial nuclear power plants began operating in the United States, there have been no physical injuries or fatalities from exposure to radiation from the plants among members of the U.S. public. Even the country's worst nuclear power plant accident at Three Mile Island resulted in no identifiable health impacts.

Federal Oversight

In the U.S., 100 commercial nuclear power reactors are licensed to operate at 62 sites in 31 States. For each site, there are onsite and offsite emergency plans to assure that adequate protective measures can be taken to protect the public in the event of a radiological emergency. Federal oversight of emergency preparedness for licensed nuclear power plants is shared by the NRC and Federal Emergency Management Agency (FEMA). This sharing is facilitated through a Memorandum of Understanding (MOU). The MOU is responsive to the President's decision of December 7, 1979, that FEMA take the lead in overseeing offsite planning and response, and that NRC assist FEMA in carrying out this role. The NRC has statutory responsibility for the radiological health and safety of the public by overseeing onsite preparedness and has overall authority for both onsite and offsite emergency preparedness.

Before a plant is licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The NRC's decision of reasonable assurance is based on licensees complying with NRC regulations and guidance. In addition, licensees and area response organizations must demonstrate they can effectively implement emergency plans and procedures during periodic evaluated exercises. As part of the Reactor Oversight

Process, the NRC reviews licensees' emergency planning procedures and training. These reviews include regular drills and exercises that assist licensees in identifying areas for improvement, such as in the interface of security operations and emergency preparedness. Each plant operator is required to exercise its emergency plan with offsite authorities at least once every two years to ensure state and local officials remain proficient in implementing their emergency plans. Those biennial exercises are inspected by the NRC and evaluated by FEMA. Licensees also self-test their emergency plans regularly by conducting drills. Each plant's performance in exercises can be accessed through the NRC website at this address: https://www.nrc.gov/reactors/operating/oversight.html.

FEMA takes the lead in initially reviewing and assessing the offsite planning and response and in assisting State and local governments, while the NRC reviews and assesses the onsite planning and response. FEMA findings and determinations as to the adequacy and capability of implementing offsite plans are communicated to the NRC. The NRC reviews the FEMA findings and determinations as well as the onsite findings. The NRC then makes a determination on the overall state of emergency preparedness. These overall findings and determinations are used by the NRC to make radiological health and safety decisions before the issuing licenses and in the continuing oversight of operating reactors. The NRC has the authority to take action, including shutting down any reactor deemed not to provide reasonable assurance of the protection of public health and safety.

Emergency Planning Zones

For planning purposes, the NRC defines two emergency planning zones (EPZs) around each nuclear power plant. The exact size and configuration of the zones vary from plant to plant due to local emergency response needs and capabilities, population, land characteristics, access routes, and jurisdictional boundaries. The two types of EPZs are:

- The plume exposure pathway EPZ extends about 10 miles in radius around a plant. Its primary concern is the exposure of the public to, and the inhalation of, airborne radioactive contamination.
- The ingestion pathway EPZ extends about 50 miles in radius around a plant. Its primary concern is the ingestion of food and liquid that is contaminated by radioactivity.

Emergency Classification

Emergency Classification is a set of plant conditions which indicate a level of risk to the public. Nuclear power plants use the four emergency classifications listed below in order of increasing severity.

- **Notification of Unusual Event -** Under this category, events are in process or have occurred which indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring offsite response or monitoring is expected unless further degradation occurs.
- **Alert -** If an alert is declared, events are in process or have occurred that involve an actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the Environmental Protection Agency (EPA) protective action guides (PAGs). Additional information regarding PAGs can be found on the EPA website at: https://www.epa.gov/radiation/protective-action-guides-pags.
- **Site Area Emergency -** A site area emergency involves events in process or which have occurred that result in actual or likely major failures of plant functions needed for protection

of the public. Any releases of radioactive material are not expected to exceed the EPA PAGs except near the site boundary.

- **General Emergency -** A general emergency involves actual or imminent substantial core damage or melting of reactor fuel with the potential for loss of containment integrity. Radioactive releases during a general emergency can reasonably be expected to exceed the EPA PAGs for more than the immediate site area.

Protective Actions

The NRC's regulations are designed to mitigate accident consequences and minimize radiation exposure to the public through protective actions. When a radiological emergency occurs, nuclear power plant personnel evaluate plant conditions and make protective action recommendations to the state and local government agencies on how to protect the population. Based on the recommendation and independent assessment of other local factors, the state or local government agencies are responsible for making decisions on the actions necessary to protect the public and for relaying these decisions to the public.

Factors that affect protective action decisions include plant conditions, competing events, weather, evacuation times, shelter factors, how quickly an incident develops, how short-lived a release of radiation may be, and other conditions.

Evacuation, Sheltering, and the Use of Potassium Iodide

Protective actions considered for a radiological emergency include evacuation, sheltering, and, as a supplement to these, the prophylactic use of potassium iodide (KI), as appropriate. Under most conditions, evacuation may be preferred to remove the public from further exposure to radioactive material. However, under some conditions, people may be instructed to take shelter in their homes, schools, or office buildings. Depending on the type of structure, sheltering can significantly reduce a person's dose compared to remaining outside. In certain situations, KI is used as a supplement to sheltering.

Evacuation does not always call for completely emptying the 10-mile zone around a nuclear power plant. In most cases, the release of radioactive material from a plant during a major incident would move with the wind, not in all directions surrounding the plant. The release would also expand and become less concentrated as it travels away from a plant. Therefore, evacuations should be mapped to anticipate the path of the release. Generally as a minimum, in the event of a General Emergency, a two-mile ring around the plant is evacuated, along with people living in the 5-mile zone directly downwind and slightly to either side of the projected path of the release. This "keyhole" pattern (Figure 1) helps account for potential wind shifts and fluctuations in the release path (Figure 2). Evacuation beyond 5 miles is assessed as the accident progresses. Also in response to a General Emergency, people living in the remainder of the 10-mile zone will most likely be advised to go indoors to monitor Emergency Alert System broadcasts.

Sheltering is a protective action that keeps people indoors, such as at home, the office, school, or a shopping mall to reduce exposure to radioactive material. It may be appropriate to shelter when the release of radioactive material is known to be short-term or controlled by the nuclear power plant operator.

Another protective action in the 10-mile EPZ involves KI, a compound that helps prevent the thyroid from absorbing radioactive iodine, one of several radioactive materials that could be present in a release from a nuclear power plant accident. If taken within the appropriate time and at the appropriate

dosage, KI blocks the radioactive iodine from being absorbed by the thyroid gland and reduces the risk of thyroid cancers and other diseases. KI does not protect against any other inhaled radioactive materials, nor will it offer protection from external exposure to radiation. The Food and Drug Administration (FDA) has determined that KI is a safe and effective drug when used for this purpose. However, there may be risks and potential side effects in using KI, including gastrointestinal disturbances, allergic reactions, and iodide goiter and hypothyroidism. Please consult your physician if you have questions on the potential side effects.

In January 2001, the NRC modified its regulations to include considering the use of KI, and, later that year, the FDA issued guidance on using the drug. The Federal Emergency Management Agency published its revised Federal Policy on the Use of Potassium Iodide in January 2002. As of October 8, 2009, 22 states have received KI tablets from the NRC for their populations within 10 miles of a nuclear power plant. These states are: Alabama, Arizona, California, Connecticut, Delaware, Florida, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, and West Virginia. Illinois has its own KI program in place; therefore, 21 of the 34 states with populations within the 10-mile EPZ have KI. Further information on KI is available on the NRC website at: https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/potassium-iodide/ki-faq.html .

After September 2001, the NRC examined how terrorist-based events might challenge existing emergency preparedness. The NRC's formal evaluation determined that, in view of the threat environment, the emergency preparedness planning basis remain valid. While a terrorist event might alter the initial response to an event, the consequences of the event will be the same whether it was caused by terrorism or a safety accident.

The nuclear power reactor's emergency plans are periodically updated and are designed to be flexible to identify, evaluate and react to the wide spectrum of emergency conditions. The NRC recognized how the terrorism threat affects emergency planning when it issued orders and guidance to nuclear power plants after September 2001. These orders and guidance include interim measures dealing with how increased security affects implementation of emergency plans. Nuclear industry groups and federal, state, and local government agencies assisted in the prompt implementation of these measures and participated in drills and exercises to test these new planning elements. The NRC has reviewed licensees' commitments to address these requirements and verified the implementation through inspections to ensure public health and safety.

Additional Information

Detailed information about emergency preparedness is contained in NRC regulations, specifically Appendix E to Part 50 of Title 10 in the Code of Federal Regulations and in NUREG-0654 (FEMA-REP-1), a joint publication of the NRC and FEMA published in November 1980, entitled "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants." These documents along with additional information on the NRC's Emergency Preparedness and Response programs is available on the NRC website at: https://www.nrc.gov/about-nrc/emerg-preparedness.html.

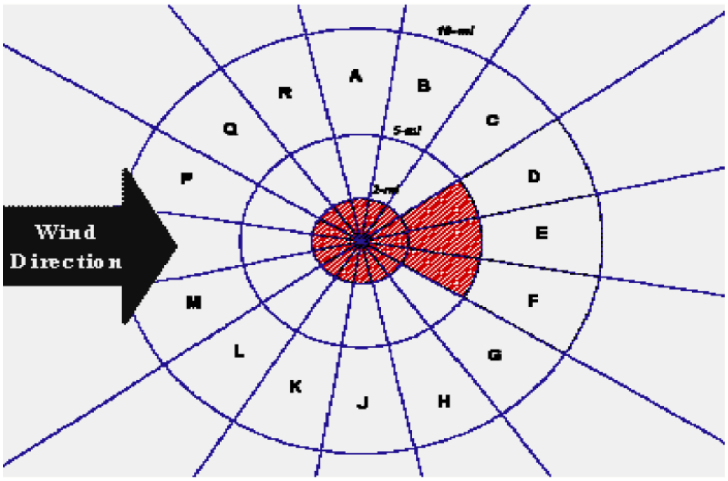

Figure 1 – "Keyhole" covering 2-mile radius and downwind sectors

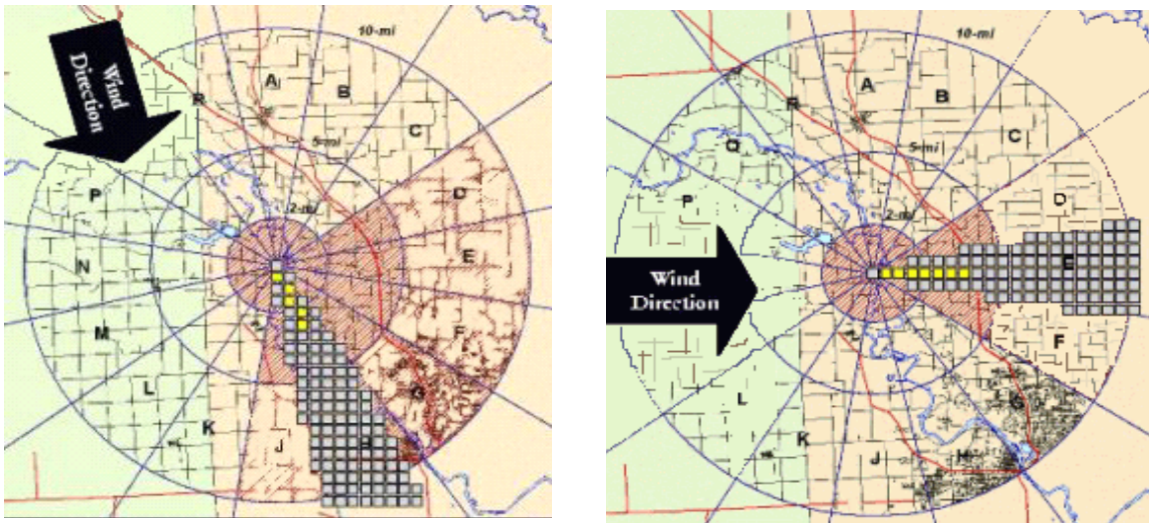

Figure 2 – Original keyhole (L) and revised keyhole following wind shift (R)

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