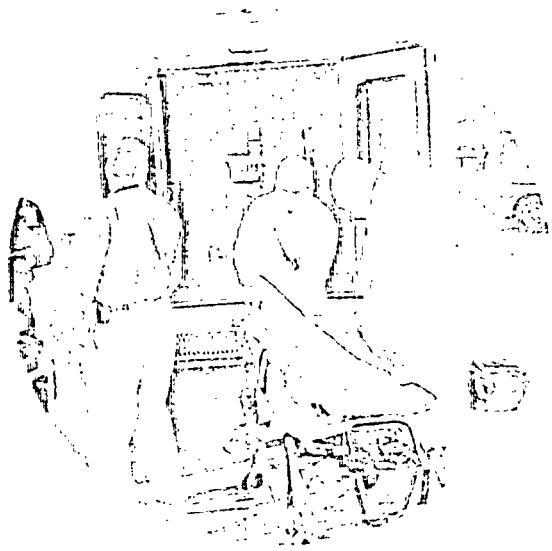
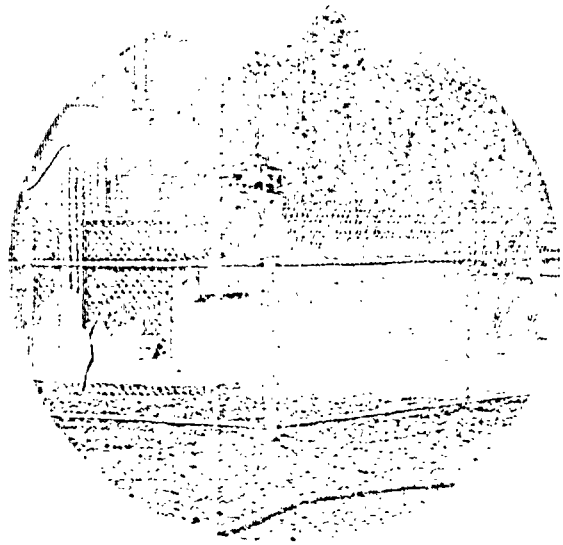
Nuclear Power Plant Emergency Preparedness



Setting the Standard for Industrial Facilities

August 2005



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I. Introduction

Sophisticated emergency preparedness (EP) plans have been part of the nuclear energy industry's commitment to safety for 25 years, and the same is true of the communities in which nuclear power plants are located.

A 1980 federal law requires energy companies to develop and exercise emergency response plans to protect the public in the event of an accident at a nuclear power plant. The U.S. Nuclear Regulatory Commission and the states in which the plants are located approve these plans. The NRC coordinates approval of the plans with the Federal Emergency Management Agency, which is responsible for off-site emergency management. To maintain its operating license, each nuclear plant must have an approved emergency response plan. These emergency plans—as with every other aspect of nuclear plant operation—are subject to constant NRC oversight.

After Sept. 11, 2001, the NRC re-examined nuclear plant emergency plans with a greater emphasis on the potential for terrorist events, and the industry made enhancements to its EP programs based on that review. The agency also has integrated its emergency response procedures with the Department of Homeland Security's (DHS) National Response Plan (NRP).

Nuclear plant emergency preparedness is a model for industrial and state government emergency preparedness nationwide. The stringent legal requirements for nuclear plant emergency preparedness far exceed those applied to other industries.

The nuclear energy industry's commitment to excellence, combined with continual training and testing, has produced an unparalleled level of preparedness. For example:

- Emergency response plans are constantly upgraded through lessons learned, regularly scheduled drills, exercises and critiques, and actual plan activations.
- Following the events of Sept. 11, 2001, the industry reassessed its emergency preparedness programs. This assessment included an industrywide review of management oversight of plant programs and communications approaches, applying lessons learned to strengthen emergency preparedness.
- Training programs are conducted annually for all emergency response personnel. The National Nuclear Accrediting Board accredits training programs for operators and technical staff who use emergency operating procedures.
- Energy companies have built emergency response facilities and upgraded existing facilities to aid in effective handling of emergencies.
- Advancements in communications technology have improved the ability to notify appropriate plant employees, emergency response personnel and the public if an event were to occur.
- The nuclear industry supports state and local off-site emergency readiness by funding, in part, emergency response personnel; development of plans and procedures; facilities; equipment; training; and participation in drills and exercises. In 2003, the industry contributed $53 million to state radiological preparedness.

The nuclear industry paid an additional $16.9 million in user fees to FEMA for fiscal 2005. These user fees are expected to increase about 15 percent for fiscal 2006, which will bring the industry total to $19.4 million.

Security and emergency preparedness have become linked to an unprecedented degree, and the nuclear energy industry is adapting to the evolving needs in these areas.

This paper provides background on the regulatory basis for today's nuclear plant emergency preparedness programs, the industry's "defense-in-depth" approach to safety, and steps the industry is taking to refine the interface between security and EP.

II. Strict Federal Regulation

Federal Agencies Establish Emergency Planning Zones

The Federal Radiological Preparedness Coordinating Committee—including representatives from the NRC, FEMA, the Environmental Protection Agency and other federal agencies—developed the planning basis for a radiological emergency in 1978. This multi-agency federal task force determined that a 10-mile radius encompassing a nuclear power facility is an appropriate emergency planning zone in the event of a release of radioactive material from the reactor. The projected radiation doses that would result from most hypothetical accidents would not be a threat to the public beyond the 10-mile zone, the task force concluded.

Evacuation and/or sheltering are required only for those residents within the 10-mile emergency planning zone, according to federal protective action guidelines.

The task force also established a 50-mile zone to limit public exposure to radioactive materials through consumption of contaminated water, milk or foods.

Although unlikely, a serious reactor accident likely would evolve over a period of several hours, thus providing time for orderly evacuation or sheltering, if necessary, in the 10-mile emergency planning zone.

Each year, the companies that operate nuclear plants provide residents within the 10-mile emergency planning zones with information explaining how emergency responders will notify them in the event of an emergency at the nuclear plant and what measures they should take. The materials also discuss the basics of radiation. Specially developed communications materials—such as telephone book inserts, booklets and calendars, which may be printed in languages besides English—also address the emergency information needs of transient populations, such as tourists.

Congress Mandates Nuclear Plant Emergency Plans

In 1980, the U.S. Congress mandated that energy companies develop, and test periodically, a comprehensive emergency response plan for each nuclear power plant. The 1980 NRC Reauthorization Act strengthened and expanded the emergency preparedness requirements already imposed on nuclear plants. The NRC and FEMA must approve nuclear plant emergency plans if the plant is to maintain its federal operating license.

In addition to federal approvals, the state in which a nuclear plant is located certifies compliance with periodic emergency preparedness requirements for the preceding year.

In 2001, the NRC revised its emergency planning regulations for nuclear power plants to provide states the option to use potassium iodide tablets as a secondary protective measure for the public.[1] Potassium iodide would supplement evacuation and sheltering in the unlikely event of a reactor accident. If taken within several hours of exposure to radioactive iodine, potassium iodide can protect the thyroid gland. It does not protect any other part of the body, nor does it protect against any other radioactive element. In 2002, the U.S. Congress passed a law to give states the option of using potassium iodide as a protective measure for the public within 20 miles of a nuclear power plant.

Scope of Nuclear Plant EP Plans: On-Site and Off-Site

Emergency plans have a broad reach, involving at least 200 employees at each nuclear power plant. NRC, state and local officials—including fire departments, law enforcement and traffic control authorities—also are included in the company's plan and participate in periodic exercises to demonstrate the plan's viability.

The two major elements in emergency preparedness for a nuclear plant are on-site and off-site response.

The on-site plan specifies how plant personnel will respond to an incident on plant property, classify the event, notify state and local emergency response officials, and manage communications.

The off-site plan, managed by local government, deals with protective actions, public notification, emergency response planning, and many other details that involve local, state and federal officials—the details most people think of when they refer to "emergency response planning." Nuclear plant personnel play an integral, but small, role in developing off-site emergency response plans, while local government officials have the lead. When the plans are implemented, plant personnel work in tandem with off-site emergency responders.

The NRC staffs an emergency response center at its headquarters 24/7. The NRC chairman or another commissioner is on call at all times to coordinate the agency's response to any emergency.

In the event of a nuclear plant emergency, the plant classifies the event on an NRC-established scale; notifies local, state and federal emergency organizations; and recommends protective action.

Local and state emergency response organizations confirm the severity of the event and determine what protective actions to take for residents within 10 miles of the plant. If necessary, protective actions can be provided beyond 10 miles. These protective actions could be a combination of evacuation, sheltering and, in some cases, the use of potassium iodide tablets. Local and state authorities must be able to activate notification systems within 15 minutes of learning about a situation requiring action.

[1] U.S. Nuclear Regulatory Commission final rule on "Consideration of Potassium Iodide in Emergency Plans" (66 Federal Register 5427, Jan. 19, 2001).

Classifying a Nuclear Plant Event

The NRC provides guidelines for classifying incidents at nuclear plants based on their potential severity, ranging from "notification of unusual event" (no emergency plan activation needed) through "alert," "site area emergency" and "general emergency."

- A notification of unusual event, the lowest classification, means that a minor plant event—either an operational event or security threat—has occurred, but no radiation release is expected.
- An alert means there is an actual or potential reduction in the plant's safety level or a security event that could threaten site personnel or damage plant equipment.
- A site area emergency suggests a more serious problem. Major safety equipment either has failed or is deemed likely to fail.
- A general emergency is the most serious event. In this instance, radiation may leak outside the plant and beyond the plant boundary.

Nuclear power plants have detailed guidelines for determining when to declare each of the event classifications. The nuclear industry is enhancing its guidelines and emergency preparedness programs to incorporate a broader range of potential activities involving hostile action. For such events, the criteria are stricter than for operational events—that is, the plant may declare an alert in the case of hostile action, even though all equipment and systems are operating normally.

Any type of nuclear plant event that requires activation of the emergency plan is rare. In 2004, the industry recorded 38 notifications of unusual events, of which 23 pertained to plant operational matters; the remainder—40 percent of the total—dealt with weather, detection of seismic activity, and other external matters. The industry had three alerts in 2004. The most recent site-area emergency took place in 1996. No general emergency has taken place since the NRC established the classification system in 1980.

NRC Integration With National Response Plan

The NRP provides an integrated, all-hazards approach for responding to an incident of national significance. Nuclear power plant events deemed of national significance are those that progress to a declaration of a general emergency and security events declared as an alert, site emergency or general emergency. The base plan provides the overall structure for emergency response. A series of "incident annexes" provides details on federal agencies' response roles in incidents of national significance, such as radiological, biological or cyber-related incidents.

The NRP recognizes the roles and responsibilities of state and local authorities. Under the plan, the federal government will assist state and local authorities when their resources are overwhelmed.

The NRP did not change significantly the NRC's role in responding to an emergency at a licensed facility. It remains the coordinating agency and technical lead for incidents involving nuclear power plants. The NRC now will coordinate its emergency-related activities with DHS, but the latter agency is not expected to become involved in nuclear plant events that do not meet the threshold for incidents of national significance.

Potential cooperating agencies—which provide additional technical and resource support—include the Federal Radiological Monitoring and Assessment Center and the federal Advisory Team for Environment, Food and Health.

The "Nuclear/Radiological Incident Annex" addresses radiological response support within the NRP. "The annex applies to any incident that has actual, potential or perceived radiological consequences within the United States ... and requires a response by the federal government," according to the NRC.[2]

The nuclear industry established the Nuclear Sector Coordinating Council to serve as the primary liaison between the commercial nuclear sector and the Nuclear Sector Government Coordinating Council on security matters.

Regulatory Oversight of Emergency Preparedness

The NRC is responsible for safety oversight of nuclear power plants and other commercial applications of nuclear materials. The agency assesses reactor performance through a combination of inspections and data on 18 performance indicators. Every reactor receives at least 2,500 hours per year of NRC inspection, a portion of which is allocated to a review of the facility's compliance with EP regulations. The NRC assesses its findings from these inspections to determine their safety significance.

Of the 18 performance indicators in the reactor oversight process, three pertain to emergency preparedness:

- drill and exercise performance
- the percentage of Emergency Response Organization members who have participated in a drill or exercise
- the working order of alert and notification system sirens, as measured by periodic testing.

Each reactor provides the NRC quarterly reports on the results for all 18 performance indicators. Resident NRC inspectors at each nuclear power plant site perform spot inspections to verify this data. The NRC posts the results for each performance indicator—along with inspection findings—on its Web site at *www.nrc.gov/NRR/OVERSIGHT/ASSESS/index.html.*

III. 'Defense-in-Depth' Approach to Plant Safety and EP

Redundant Plant Systems Help Ensure Safety

It is vital to plan for an emergency at a nuclear power plant and to be ready to act quickly and efficiently to protect plant workers and the public, should that become necessary. The best way to keep the public safe is to keep the plant safe, and that is the foundation of emergency preparedness. Safety is the nuclear industry's top priority. Emergency plans then address the "what if" scenario: What if key safety features were to fail?

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[2] NRC Regulatory Issue Summary 2005-13, July 13, 2005.

Nuclear plant safety is based on the concept of "defense-in-depth" design and construction. Nuclear power plants are among the strongest industrial facilities ever built. The structure containing the reactor—called the containment building—is made of steel-reinforced concrete with walls four feet thick. Reaching the reactor requires penetrating another eight feet of concrete in various structures. Finally, there is the reactor itself, housed in a massive steel vessel 4 to 8 inches thick and weighing more than 300 tons.

Redundant safety systems are designed to maintain the reactor in a safe condition. This redundancy ensures that everything that must be done to keep a plant safe can be done in two or more ways.

The same features that protect the public also protect the plant's nuclear fuel from outside threat. They can keep the plant safe regardless of the cause of the emergency.

Federally Licensed Operators

Another vital element of the industry's commitment to safety is the federally licensed nuclear power plant operators—carefully selected, highly trained professionals. Operators train about one week out of every five, and they must requalify for their licenses every two years. NRC regulations also require operators to participate in emergency drills and exercises.

Every nuclear power plant has a set of emergency operating procedures that instruct the operators on what actions to take under a wide range of potential plant operating conditions. These procedures cover every type of potential accident that the plant is required to withstand. The NRC and the industry have taken additional steps in accident preparation, considering possible scenarios of extremely low probability. Each plant has a set of severe accident management guidelines to assist operators and their technical advisers in the remote likelihood that the plant enters an extreme operating condition not addressed by emergency operating procedures.

Redundant safety systems, highly trained operators and extensive emergency procedures greatly reduce the probability of a severe accident and potential radiological release. These features are designed to prevent accidents and, should one occur, to mitigate its effects.

However, emergency preparedness starts from the assumption that none of these safety systems work.

For the purposes of emergency preparedness exercises, it is assumed that numerous backup safety systems fail, the operators are unsuccessful at using alternative means to keep the plant safe, and their technical advisers are unable to help. At this point in the exercise, the plant enters its emergency plan and procedures. Nuclear plant emergency plans take into account both operational and security-related emergencies.

IV. Emergency Preparedness in the Real World

Local officials have successfully activated emergency response plans developed by the nuclear industry for use in other emergencies. All the evacuations were performed safely and in an orderly fashion. Two examples:

- The evacuation of 10,000 people from Cedar Rapids, Iowa, in 1985, following a fire at a city-operated sewage treatment plant that dispersed a cloud of toxic fumes over the city. State and local officials used a draft plan developed for the Duane Arnold nuclear plant.

- The evacuation of 17,000 residents of St. Charles Parish, La., following a leak from a nearby chemical plant in December 1982. State and local officials worked from a draft plan for Entergy's Waterford 3 nuclear plant, which was not yet operating.

There has never been the need to activate a nuclear plant emergency preparedness plan to deal with a radiological event.

Dispelling Myths About Public Behavior

Sociologist Dennis Mileti has found that several myths persist about the way people respond to warnings about emergencies. One thing they do not do is panic, Mileti said.

Mileti is professor emeritus at the University of Colorado at Boulder and emeritus director of the university's Natural Hazards Center. In 2000, he published an article, "The Social Psychology of Public Response to Warnings of a Nuclear Power Plant Accident," in the Journal of Hazardous Materials.[3] "Not only the general public, but surprisingly many emergency managers as well, believe in a set of widespread myths about public response to warnings," he stated in the journal article.

"First, it cannot be overemphasized that the public simply does not panic in response to warning of impending disasters, including nuclear power plant accidents," he said. "This myth is largely the result of movie producers who depict masses of screaming, fleeing, completely panicked individuals in dangerous situations." He differentiated between "panic behavior" and elevated stress, which "the public and media often label as panic."

Rather than panic in response to warnings, Mileti said, "people typically respond by doing everything in their power to obtain more information." He also found that people are more likely to believe warnings and requests for action, such as sheltering or evacuation, when communications are clear, frequent and consistent.

Mileti's findings about public response to emergency warnings underscore how important it is for nuclear power plant and local emergency responders to communicate often with the public under everyday circumstances, helping to build trust and credibility.

Assessing the Effectiveness and Safety of Evacuations

A 2004 study of large-scale evacuations by Sandia National Laboratory found that they are "very effective and successfully save lives and reduce the potential number of injuries associated with the hazard."[4] The finding held true whether the evacuations were planned or ad hoc.

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[3] Journal of Hazardous Materials, June 28, 2000.

[4] "Identification and Analysis of Factors Affecting Emergency Evacuations," NUREG/CR-6864, Vol. 1; SAND2004-5901, U.S. Nuclear Regulatory Commission, January 2005.

The study found that close coordination among emergency response entities is an "overwhelming factor" contributing to the success of an evacuation.

Starting with a sample of 230 large-scale evacuations between 1990 and 2003, Sandia selected 50 for detailed case studies. The resulting 50-case sample included five evacuations of more than 100,000 people, ranging from 270,000 to 666,000, both for hurricanes. One of the five was the Sept. 11, 2001, evacuation of lower Manhattan after the attack on the World Trade Center. The 50 detailed case studies also included 33 evacuations dealing with technological hazards. No radiological-related evacuations occurred during the timeframe covered by the study.

The study found that close coordination among emergency responders, training and exercises contribute to the effectiveness of evacuations. All 50 communities provided training to their emergency response personnel; 40 percent conducted full-scale exercises.

V. Ongoing Initiatives in Emergency Preparedness

Planning for possible emergencies is an ongoing process and is a partnership between the company that operates a nuclear plant and state and local officials. World events of the past several years have heightened the need for emergency preparedness and security programs to work seamlessly together. Following the events of Sept. 11, 2001, the industry enhanced its preparation for dealing with terrorist events by implementing compensatory orders and EP lessons learned from force-on-force drills. The nuclear industry continues to enhance its emergency preparedness programs.

The nature of any potential radiological release is the same whether a reactor incident stems from equipment malfunction, human error or deliberate sabotage. But a security threat or breach adds uncertainty because the actions of would-be saboteurs—while they can be hypothesized—cannot be modeled with the same precision as the response of plant equipment. The nuclear industry is enhancing its emergency plans to address the increased potential for the threat of hostile action.

NRC Bulletin Addresses 'Hostile Action'

The NRC issued a bulletin in July that addresses emergency preparedness in the context of "hostile action," a new term that will be added to the list of definitions in nuclear plant emergency plans:

- ***Hostile Action:*** "An act toward [a nuclear power plant] or its personnel that includes the use of violent force to destroy equipment, take hostages and/or intimidate the licensee to achieve an end. This includes attack by air, land or water, using guns, explosives, projectiles, vehicles or other devices used to deliver destructive force."[5]

The bulletin asked the companies that operate nuclear plants to provide information to the NRC on actions they have taken, or plan to take, to modify their emergency plans to reflect security-based events more fully.

[5] NRC Bulletin 2005-02, July 18, 2005.

"The information in this bulletin does not indicate that additional or earlier radiological protective actions are required to ensure [radiation] dose avoidance," the NRC stated. "However, this bulletin conveys that a security-based event may introduce the need to relay information or protect plant personnel in a manner different from events for which licensees and off-site response organizations typically plan and train."

Three industry guidelines are assisting nuclear plant emergency response organizations in responding to this changing environment.

The Nuclear Energy Institute's (NEI) revised emergency action level guideline, NEI 99-01, Rev. 4, includes the new emergency action levels related to hostile events.

The industry also developed guidance for enhancing emergency preparedness programs. The guidance—developed by NEI's emergency preparedness and security working groups—considers scenarios involving hostile attacks and the potential implications for emergency preparedness. The enhancements fall into five areas:

- security-based emergency action levels
- prompt NRC notification
- protective measures for on-site personnel
- augmentation of emergency response organizations
- integrated emergency preparedness/security drills.

Separate industry guidance addresses the range of protective actions that a nuclear plant may consider using during the early phase of an emergency situation. NRC regulations require nuclear plants to make recommendations of protective actions for the public to local officials, who ultimately decide what actions to implement. The NRC also requires the industry to recommend sheltering if a company's analysis indicates that is appropriate, whether or not states choose to consider that option.

The industry guidance addresses four issues related to evacuation and sheltering:

- decision points for recommending evacuation
- decision points for recommending sheltering
- the use of sheltering as an alternative to evacuation for short-term radiological releases
- the use of sheltering when evacuation is impractical because of impediments, such as bad weather or inadequate roads.

Integrated Emergency Preparedness/Security Drills

The nuclear energy industry and the NRC are pilot testing a plan for integrating a security-threat response into the emergency preparedness drills performed every other year at each nuclear power plant.

Plants perform these drills in "off years" between the NRC-required biennial exercises performed in coordination with state and local emergency organizations to demonstrate regulatory compliance. Traditionally, these exercises and drills have been based on operational plant events, such as equipment malfunctions that could lead to a radiological

release. NEI's emergency preparedness and security working groups developed a plan to integrate events initiated by security threats into the drills.

A security component will be part of the off-year drills at nuclear plant sites during the next three to four years, and the experience from the drills will be incorporated industrywide through lessons-learned workshops. Each site will complete at least one such drill. Once NEI obtains NRC endorsement of the industry guidance on an integrated EP/security drill program, each plant will include a security event in its biennial EP compliance exercise.

In July 2005, Pacific Gas & Electric Co. piloted a tabletop security-driven emergency preparedness exercise at its Diablo Canyon nuclear power plant. The tabletop consisted of two phases. The initial event response phase addressed receipt of threat information and the near-term actions associated with classifying the event, notifying authorities, and actions to protect workers and the public. The post-event response phase addressed how emergency response organizations deal with the potential loss of large areas of the plant because of hostile actions.

The Diablo Canyon tabletop drill began with a notification to the control room that an airliner with apparently hostile intentions was within 30 minutes of the plant and heading toward it.

Any potential event related to hostile action, rather than plant operations, changes the planning landscape. For example, emergency plans must reflect different assumptions about the location and availability of plant personnel.

The integrated emergency preparedness/security scenario for the Diablo Canyon tabletop drill included an airliner crash and possible effects on safety and communications equipment, as well as casualties—which are not a factor in an operations-related drill.

The tabletop drill is one example of how the industry is enhancing emergency preparedness to address the changing security environment for nuclear plants.

VI. Conclusion

Nuclear power plants are safe and secure because of a defense-in-depth approach: strong construction, redundant safety and security systems, and highly trained reactor operators. Additionally, emergency plans are well-developed and tested, with substantial involvement by local, state and federal authorities.

These plans have proved effective in a wide range of situations unrelated to nuclear plant operation, such as storms, floods and chemical spills. They represent an established partnership between the local communities and the nuclear energy industry—and a level of emergency preparedness that few other communities have.

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