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EXECUTIVE SUMMARY

On August 1, 2002, Governor George E. Pataki announced a comprehensive and independent review of emergency preparedness to be performed by James Lee Witt Associates (JLWA) for the area around the Indian Point Energy Center ("Indian Point"), and for that portion of New York in proximity to the Millstone nuclear plant ("Millstone") in Connecticut. James Lee Witt Associates subcontracted with Innovative Emergency Management ("IEM") for portions of the review. The review encompassed many related activities that were designed, when taken together, to determine whether the existing plans and capabilities of the jurisdictions involved are sufficient to ensure the safety of the people of New York in the event of an incident at one of these plants, and how those existing plans and capabilities might be improved. In addition to an outreach effort into the surrounding communities, the review included recent exercise results and public information efforts, current radiological emergency response plans, and the data underlying the response plans, such as population data, the methodology of evacuation time estimates, alert and notification system specifications, Off-site accident impact analysis methodologies, and communication capabilities.

It should be noted that we were not asked to look at the safety of the plants themselves, the availability of alternate energy sources, the economic and environmental costs and benefits of the plants, or other factors relevant to an overall picture of the plants within their respective communities. Consequently, nowhere have we taken a position on the future status of the plants.

During our review we were frequently asked whether we were under constraints. We were guided by our experience and were unconstrained in our recommendations.

Major Findings

Plans and Exercises

1. The plans are built on compliance with regulations, rather than a strategy that leads to structures and systems to protect from radiation exposure.

2. The plans appear based on the premise that people will comply with official government directions rather than acting in accordance with what they perceive to be their best interests.

3. The plans do not consider the possible additional ramifications of a terrorist caused event.

4. The plans do not consider the reality and impacts of spontaneous evacuation.

5. Response exercises designed to test the plans are of limited use in identifying inadequacies and improving subsequent responses.

These planning problems are more serious because of the large population concentrations near the Indian Point plant, and when the effectiveness of the plan requires a degree of public and responder confidence that is largely absent. Thus the consequences of the five general findings above are more serious for the communities around Indian Point than for New York jurisdictions closest to Millstone.

Regulations

The Nuclear Regulatory Commission ("NRC") has stated as recently as November 18, 2002, that a preliminary assessment of the capabilities of, and compliance by, the State and its jurisdictions by the Federal Emergency Management Agency ("FEMA"), based on the September 24, 2002 exercise, indicates the Off-site emergency plans are adequate to protect public health and safety. While under the current regulations that may be technically true, we are concerned that when plans and exercises, which omit such things as a realistic consideration of spontaneous evacuation and the unique consequences of a terrorist attack, still meet NRC and FEMA regulations, then those regulations need to be revised and updated on a national basis. We believe any plant adjacent to high population areas should have different requirements than plants otherwise situated, because protective actions are more difficult and the consequences of failure or delay are higher. The standard, to minimize the radiological dose to the public, would remain the same; its accomplishment necessitates higher requirements in some communities than others.

Some may look at our findings, conclusions, and recommendations and read them, incorrectly, as an indictment of FEMA or the State and its jurisdictions, and their staff and leadership. FEMA has recognized the need to change in the direction of a more performance-based approach in its exercise program. Although the change does not go far enough, it began with a multi-year strategic review of the Radiological Emergency Preparedness Program, and resulted in a new exercise methodology developed prior to 9/11 and published in the Federal Register on September 12, 2001. This beginning of a change in exercise theory to focus on performance outcomes was not found in the planning and exercising practices of the State of New York and its jurisdictions however. We hope our recommendations will accelerate both regulatory and cultural changes.

Also, while we do have many recommendations for further change that impact on the systems and practices of FEMA and others, we recognize that these systems and practices were developed in a different environment. Simply stated, the world has recently changed. What was once considered sufficient may now be in need of further revision. We hope that those at all levels of government with emergency management responsibilities will consider our suggestions in a manner that is consistent with their high standards and professional experience.

Major Conclusions

Indian Point Safety

In our report we discuss significant planning inadequacies, expected parental behavior that would compromise school evacuation, difficulties in communications, outdated vulnerability assessment, the use of outdated technologies, lack of first responder confidence in the plan(s), problems caused by spontaneous evacuation, the nature of the road system, the thin public education effort, and how these issues may impact an effective response in a high population area. None of these problems, when considered in isolation, precludes effective response. When considered together, however, it is our conclusion that the current radiological response system and capabilities are not adequate to overcome their combined weight and protect the people from an unacceptable dose of radiation in the event of a release from Indian Point. We believe this is especially true if the release is faster or larger than the typical exercise scenario. Should our recommendations be successfully implemented it is possible that an improved exercise program will demonstrate that a different conclusion is warranted.

Millstone Safety

Although most of the problems mentioned above also apply to those New York jurisdictions near Millstone, their consequences are significantly less for reasons detailed in the report. The response system and capabilities of those jurisdictions, though inferior to those near Indian Point, should be able to protect New York citizens from an unacceptable dose of radiation in all but the most extreme event. Implementation of our recommendations should dramatically increase that margin of safety.

Major Recommendations

Plans

Plants adjacent to high population areas should have different requirements than plants otherwise situated, because protective actions are more difficult and the consequences of failure or delay are higher. Many of our specific recommendations are designed to assist the State and its jurisdictions in meeting the higher requirements we believe need to be developed primarily at the Federal level.

Also, the plans appear to be based on the assumption that people will comply with official directions. We recommend the implementation of a continuous effort that assesses existing attitudes and expected behaviors, and planning (and public education) that is based on the results of these efforts.

The plans are designed to allocate responsibilities for emergency functions. The current format and structure does not easily allow integration of information such as evacuation time estimates, what segments of the public believe and intend, and risk and threat assessments. The plans should discuss and evaluate strategies for protecting people in a variety of scenarios.

Terrorism

There are unique aspects of a terrorist caused incident that should be considered in planning and exercising. For example:

- The possibility of multiple obstructions of evacuation routes that are additive to those that would occur in a "normal" evacuation. Because they can be assumed to be deliberately designed to cause disruption, they may also be more difficult to address than normal evacuation problems.
- The possible targeting of responders.
- The possibility that spontaneous and/or shadow evacuation may be more of a problem than it would be in a non-terrorist event.
- The probable presence of a crime scene that may significantly change the communication and coordination aspects of a disaster response, as occurred in Oklahoma City.
- The probable diversion of those required to respond to the attack from response related law enforcement activities such as the safe evacuation of the affected populace.
- The probable involvement of agencies, such as the FBI, in both on site and off site activities in ways planners who now refuse to contemplate the unique implications of the terrorist threat have not yet considered.

It is important to note that a terrorist event need not result in a release for some of the above possible consequences to come into play. The unique aspects of a terrorist event should not be dismissed by simply asserting that they are covered in current plans and exercises.

Communications

As is often the case in emergency response, interoperability and other communications shortcomings among the response agencies and jurisdictions hinders effective response, especially in areas of hilly terrain. The adjacent counties should have a priority in any communications project the State may undertake.

Also, municipalities within and beyond the ten-mile planning zone should have access to direct notification and information on current plant conditions and projections. A one-way flow of information supplementing current notification processes would help local officials get ahead of problems and retain public confidence.

Ten-Mile Emergency Planning Zone

There is a likelihood of significant unnecessary evacuation within and beyond the ten-mile zone. Such an evacuation has serious public safety implications. Planning at all levels of government must reflect this likelihood.

Public Education

Because evacuation is often assumed to be the only effective protective action, and because spontaneous evacuation is a problem for public safety, training relative to sheltering-in-place is necessary, well beyond the ten-mile zone. Also, effective public education must be designed and initiated if aspects of the plan that are sensitive to public response are to be effective. Because many essential personnel indicate they will take care of their families, instead of focusing on their response activities, training on emergency family protection should be a component of this public education effort.

Exercises

We observed the full-scale exercise of Indian Point held in September 24, 2002 but there was no comparable Millstone exercise for us to observe. The exercise program, of which the September 2002, exercise was a part, simply does not measure the performance outcome of the emergency response system. The results of the exercises are not as reflective of the status of preparedness as some consider them to be.

The exercise program uses a functional approach to exercise evaluation. The concept is to outline every function to be performed, analytically break down each function, and review the performance of the system using the functions and the points of review. The notion is that each atomized function can be reviewed separately and can be judged on its own merit.

The current approach to exercises is valuable in improving specific parts of plans. But an emergency response system should not be viewed functionally. It is a system where each part is connected to the whole. The system includes warning, dose assessment, protective action recommendations, instructions to the public and so forth. A break in the chain of activities may mean that the goal is not met.

The State should work with FEMA and others to develop a performance outcome-based exercise program distinctly different from the functional exercise approach. A functional approach examines each activity against regulations, guidance, or plans and looks for compliance. An outcome-based approach looks for the effects of the actions on the community.

Exercise Scenarios

The implications of a release faster or larger than those now being addressed also need to be considered. The low end of the time range specified in NUREG 0654 (as low as one-half hour) is not being sufficiently exercised. In addition, the participating organizations need to focus on measuring how quickly the population is being affected versus the speed with which protective actions are being accomplished. Similarly, in the case of larger releases, we cannot verify that the larger end of the accident spectrum is being accommodated. The vigorous debate about whether a terrorist event actually increases the probability of such releases, about which we did not offer an opinion, should not detract from the need to address faster and larger releases.

Large shadow evacuation, especially for a terrorist event, should be included. These scenarios should be selected for their ability to test varying concepts for protecting people. A broader part of the community, including those publicly skeptical of the plans, needs to be involved in the development of the exercises as well as be able to participate and observe the exercises.

Response Management Technologies

The Indian Point region is using old technologies in a number of areas. The hazard assessment process uses 25 to 30 year old map overlays for determining the area at risk. The hazard information specific to the dose assessment is communicated via phone or fax to the State and Counties. Plume information is currently not available through operable automation systems that can show the State and counties the precise areas that are at risk. Assessments do not integrate with population data and do not show the time that various zones would be at risk.

In providing warning to the people, there is an over-reliance on outdated sirens and the Emergency Alert System. Newer technologies, such as tone alert radios, have not been widely implemented.

When making protective action decisions, officials must consider what has happened, how it could affect people, the time windows available for actions, action alternatives, and the resources and constraints attendant on each action alternative. Currently, the protective action decision-making process is very simplistic, and there is virtually no technology support for these decisions.

We recommend that the Emergency Operations Centers (EOCs) and the technology supports for protective actions be significantly upgraded.

Public Review

On January 10, 2003 James Lee Witt Associates completed the draft review. Because of the importance of the subject to the citizens and stakeholders in the area, and because we thought consideration of comments would improve the report, JLWA thought it appropriate that the public have an opportunity to provide comments on any aspect of it. The State concurred in this assessment and approach.

The comments received are recorded and discussed in a new appendix, Appendix K.

FEMA also commented on our draft report. Although it was sent two weeks after the close of the comment period, and not to us, we requested additional time from the State so that we could address their comments. We requested the additional time, and it was granted, because FEMA is the federal agency with purview over many of the issues we discuss, and we felt they and others should have benefit of our responses in their subsequent actions and decisions. Our consideration of the FEMA report can be found in a second new appendix, Appendix L.

CHAPTER 1
INTRODUCTION

Recent national events have resulted in a reassessment of public safety and security measures at nuclear facilities across the United States. Both the nuclear facilities themselves and the states and counties in which they are located are working to ensure that emergency response systems are as effective as possible.

The State of New York recently contracted with James Lee Witt Associates to conduct a comprehensive and independent review of emergency preparedness for the communities around the Indian Point Energy Center ("Indian Point"), and for those New York communities near the Millstone Nuclear Power Station ("Millstone") in Connecticut. The review was envisioned as encompassing many related activities designed, when taken together, to shed light on whether the existing plans and capabilities of the jurisdictions involved are sufficient to ensure the safety of the people of New York in the event of an incident at one of these plants. As Indian Point is located just 30 miles north of Manhattan and a short distance from large concentrations of population, concerns about public safety in the area around the facility are understandably high. A large body of water separates Long Island from Millstone, but Fishers Island—a small resort island—and Plum Island, where the Plum Island Animal Disease Center is located, are both within the ten-mile, or "plume," emergency planning zone. The purpose of this study is to assess the ability of emergency management systems to protect the health and safety of the New York citizens living around Indian Point and Millstone in the event of a radioactive release. The study includes recommendations for improvements in the emergency management systems for each site.

James Lee Witt Associates ("JLWA") subcontracted with Innovative Emergency Management, Inc. ("IEM") to assist in this review of the critical preparedness components at Indian Point and Millstone and their jurisdictions, including evacuation, public warning, communication and coordination among response agencies, compliance of emergency plans with industry regulations, and other emergency preparedness issues.

1.1 Organization of this Document

This document presents the results of the JLWA/IEM review. It is organized as follows:

- Chapter 1, *Introduction*, introduces and provides the organization of the document.
- Chapter 2, *Background*, includes the location and description of the two plants as well as a discussion of emergency management systems.
- Chapter 3, *Description of the Hazard*, explains the nature and likelihood of a radiological release from a nuclear plant, plume behavior, effects of radiation on health, and guidelines on absorbed dosages. The chapter also includes findings from an Off-site Accident Impact Analysis review for both plants.
- Chapter 4, *Review of Emergency Plans: Compliance with Regulations*, explains the significance of radiological emergency preparedness plans. This chapter also contains the

results of JLWA/IEM's review of the radiological emergency preparedness plans for Indian Point and associated jurisdictions (the State of New York and the counties of Westchester, Rockland, Putnam, and Orange) and Millstone and associated jurisdictions (the State of Connecticut, Suffolk County, and Fishers Island).

- Chapter 5, *Emergency Planning Bases and Systems*, reviews some of the important planning bases and systems used for planning related to Indian Point and Millstone, including demographics, evacuation time estimates, alert and notification systems, and communications technology used by emergency personnel.
- Chapter 6, *Review of Training Programs*, discusses training in the context of an overall emergency management system. The chapter also reviews Indian Point training programs and training programs that affect the populations of Fishers Island and Plum Island.
- Chapter 7, *Review of Public Information and Education Program,* discusses the current levels of public awareness and public education. This chapter also includes an analysis of past public outreach efforts including public information materials.
- Chapter 8, *Review of Previous Inspection and Exercise Reports*, explains the importance of an exercise program in the context of an emergency response system. This chapter also includes an analysis of past inspection and exercise reports for Indian Point and Millstone.
- Chapter 9, *Architecture for Analyzing Coordinated and Integrated Response*, discusses a theoretical framework (*Public Protection Performance Architecture [P3A])* for conducting a rigorous review of emergency management decision-making and practice.
- Chapter 10, *Exercise Analysis Using the Public Protection Performance Architecture (P3A)*, applies the principles discussed in Chapter 9 to exercise data collected for the region around Indian Point
- Chapter 11, *Conclusions and Recommendations Regarding Public Safety*, provides conclusions and recommendations.
- Appendix A, *Approach to the Statement of Work*, describes the approach to the outreach, public education, historical, planning, and operations reviews of Indian Point and Millstone.
- Appendix B, *Detail on Off-site Accident Impact Analysis Review*, gives detailed information on dose assessment methodology for Indian Point and Millstone.
- Appendix C, *Individual Plan Review Compliance Matrices*, contains review tables of radiological emergency preparedness plans for Indian Point, the State of New York, and the counties of Putnam, Rockland, Orange, and Westchester and also for Millstone, the State of Connecticut, Fishers Island, and Suffolk County.
- Appendix D, *Detail on Population Basis Review*, gives detailed information on population data for Indian Point and Millstone.
- Appendix E, *KLD's Evacuation Network (from Field Survey)*, includes a table of differences noted between IEM's review of evacuation routes and the evacuation network for Indian Point developed by KLD Associates.
- Appendix F, *Details on Alert and Notification System Review*, discusses the characteristics of the sound propagation model used to generate siren-level contours for Indian Point.

- Appendix G, *FEMA Exercise Report Findings*, lists areas requiring corrective action and other significant issues noted in FEMA exercise reports for Indian Point and Millstone.
- Appendix H, *NRC Inspection Report Findings*, lists findings relevant to emergency preparedness as noted for Indian Point and Millstone in NRC inspection reports.
- Appendix I, *2002 Indian Point Practice and Full-Scale Exercise Observations*, includes a table of observations grouped as they relate to management processes.
- Appendix J, *Advocacy Group Issues,* defines how the term "advocacy groups" is used and summarizes issues they raise.
- Appendix K, *Response to Comment Period*, analysis and response to public comments.
- Appendix L, *Response to FEMA Report*, analysis and response to FEMA comments. *(Estimated date of publication-week of March 10, 2003)*

CHAPTER 2
BACKGROUND

This section provides context for and information related to the location, topography, and economic impacts of Indian Point and Millstone as well as the populations that could be affected by a radiological accident at each site. It also includes a discussion of the safeguards in place at nuclear plants and the criticality of effective emergency response systems.

2.1 Location and Description of Indian Point[1]

Indian Point covers approximately 239 acres located on the east bank of the Hudson River about 24 miles north of New York City, within the Village of Buchanan, in upper Westchester County. The Indian Point facility currently has two reactors, Unit 2 and Unit 3, in operation.

The radiological emergency preparedness plan[2] for the Indian Point facility accounts for populations residing in an approximate ten-mile circular area surrounding the plant, which is called the plume emergency planning zone. This zone contains portions of Orange, Putnam, Rockland, and Westchester counties, in which just over 298,000 residents currently reside. Bear Mountain State Park, Harriman State Park, and the U. S. Military Academy at West Point are also located within the emergency planning zone.

[1] Information excerpted from "Putnam County Radiological Emergency Response Plan."
[2] *Indian Point Energy Center Emergency Plan Draft*, revised February 2001.

The ten-mile plume emergency planning zone for this area is depicted in Figure 2-1 below.

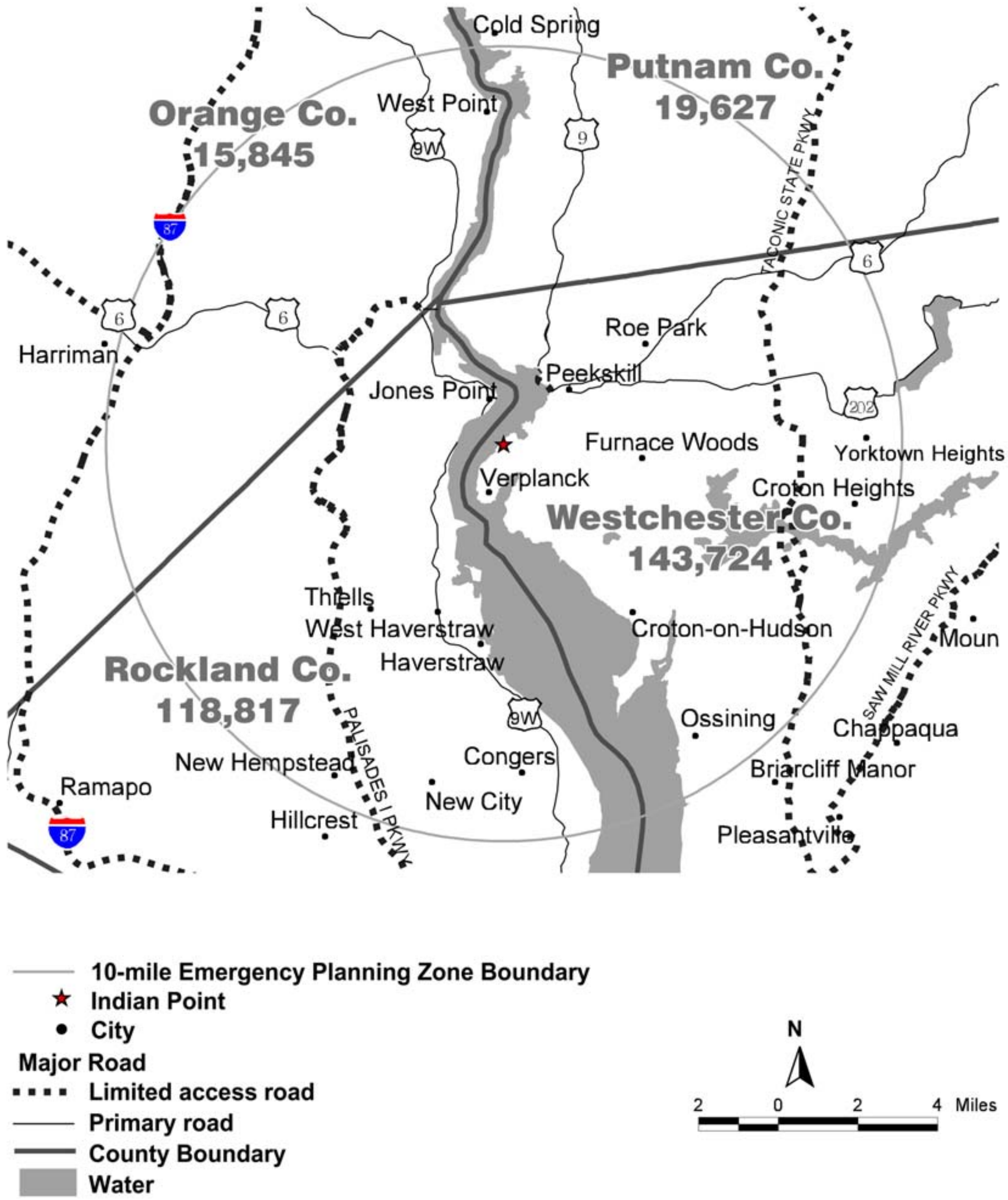

Figure 2-1: Permanent Residential Population in Region Encompassing the Indian Point Ten-Mile Emergency Planning Zone

Stretching beyond this region is the 50-mile, or "ingestion," emergency planning zone which encompasses additional cities and counties, including New York City, as well as portions of New Jersey and Connecticut. We use the term "cities" generically, recognizing that there is a relationship among Towns, cities and villages that is complex and not well known to many who will read this report. The ingestion emergency planning zone is depicted in Figure 2-2.

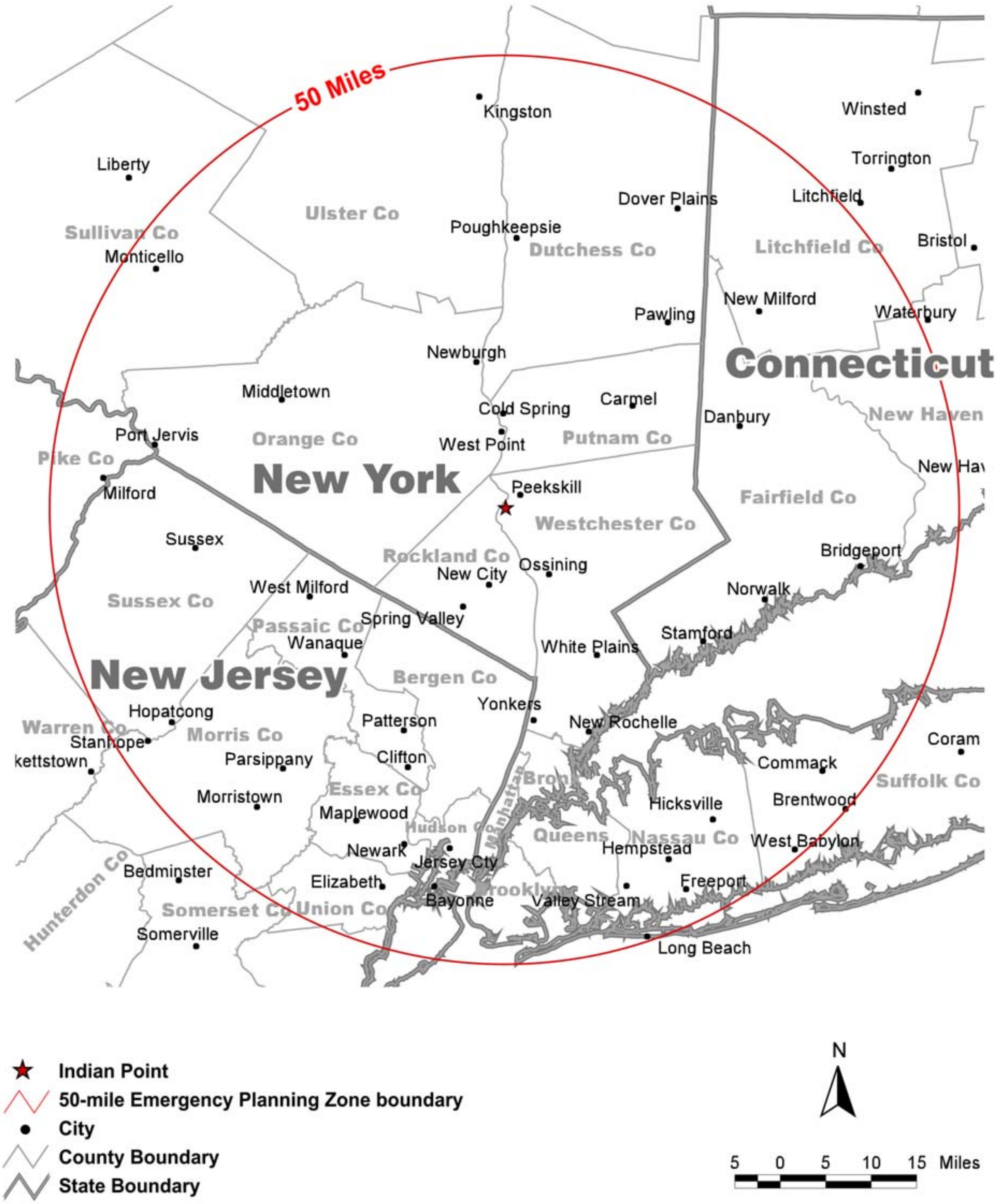

Figure 2-2: 50-Mile Ingestion Pathway Emergency Planning Zone around Indian Point

The terrain in the ten-mile plume emergency planning zone surrounding the Indian Point facility is characterized primarily by the river valley, but also contains rolling hills and forested areas. Because the plant is situated on the Hudson River, the river valley will likely be the strongest influence on the movement of any release of any radiological material from Indian Point, either directly or indirectly. If a release were to occur during conditions of low wind speed, and the wind was blowing in the direction of the river valley, the valley would essentially serve as a conduit for the plume, or radioactive cloud. Likewise, if a slow wind moved the release toward a forested or hilly area, the plume would move through the “cuts” or low points of these features (e.g., in the valleys between hills) much as it would through the river valley. If the wind were blowing quickly, a plume would be more likely to move with the direction of the wind and be less affected by the topography. (See Chapter 3 for more discussion on plume behavior.)

The Hudson River Valley significantly affects the movement of air near Indian Point. During the day, when wind speed in the area is low, the Hudson River Valley produces local effects that cause air flow to move predominately toward the north or northeast up the river valley. At night, under conditions of low wind speed, local effects would cause a wind that moves predominately toward the south or southeast down the river valley. When winds are strong, movement would be predominantly southeastward to east-southeastward across the valley (refer to Section 3.5 for more information).

Additionally, the hilly terrain in the area may reduce the effectiveness of the sirens. Extremely hilly terrain will create zones where siren sounds may not propagate effectively. The effectiveness of cellular and radio communication systems may also be affected by the hilly terrain (Sections 5.2 and 5.4 discuss sirens and communications systems in more detail).

2.2 Descriptions and Demographics of Counties Surrounding Indian Point

The following descriptions of the counties surrounding Indian Point are provided because demographics and other physical attributes are important when developing protective action strategies and effective means of communicating for ethnically, culturally and/or linguistically diverse communities.

2.2.1 Orange County Description

Orange County, New York, is bordered by the Hudson River on the east and the Delaware River on the west, and covers 816 square miles. Located approximately 60 miles north of New York City, approximately one-third of the total area is devoted to agriculture. Residential land comprises percent of the total county land area and another 40 percent is vacant land. The U.S. Military Academy at West Point is located within the county and within the 10 EPZ. According to the 2000 Census, Orange County has 341,367 residents. Of that population:

- 83.7 percent are White.
- 11.6 percent are of Latino or Hispanic origin.
- 8.1 percent are Black or African Americans.

- 1.5 percent are Asian.

In Orange County, 8.4 percent are foreign born and 4.3 percent are not citizens. Also, 18.2 percent speak a language other than English at home; 44 percent of which speaks English "less than very well." This group represents:

- 39.1 percent of Spanish language speakers,
- 49.4 percent of Indo-European language speakers, and
- 44.4 percent of Asian and Pacific Islander language speakers.

2.2.2 Putnam County Description

Putnam County has a land area of 235 miles. The County is approximately 50 miles north of New York City and bordered Dutchess County to the north, Westchester County to the south, the State of Connecticut to the east and the Hudson River to the west. Within the County are six towns: Carmel, Kent, Patterson, Philipstown, Putnam Valley and Southeast; and three incorporated villages: Brewster, Cold Spring and Nelsonville.

The County is principally residential in character and combining suburban and rural settings. The 2000 population was 95,745. Of that population:

- 93.9 percent are White.
- 1.6 percent are Black or African American.
- 6.2 percent are of Latino or Hispanic origin.
- 4.5 percent are Asian, American Indian or another ethnicity not listed above.

More than 13 percent speak a language other than English at home; 35.6 percent of which speaks English "less than very well." This group represents:

- 41.2 percent of Spanish language speakers,
- 31.4 percent of Indo-European language speakers, and
- 42.9 percent of Asian and Pacific Island language speakers.

In the county, 8.8 percent of the population is foreign-born and 4.2 percent are not citizens.

2.2.3 Rockland County Description

Rockland has land area of 176 square miles. The County is approximately 33 miles northwest of Manhattan and is bordered by Orange County to the north and west, Bergen County, New Jersey to the south and the Hudson River to the east. Within the County are five towns, Clarkstown, Haverstraw, Orangetown, Ramapo and Stony Point, 19 incorporated villages and nine independent school districts.

Southern portions of the County, including the Towns of Clarkstown, Orangetown and Ramapo are proximate to the New York State Thruway and are well developed and heavily populated. Approximately 83 percent of the County's population resides within this area. Northern sections of the County, including the Towns of Haverstraw and Stony Point, are more rural due to the extensive systems of parks located in this part of the County.

New Square village, (pop 4,624 in the 2000 census) in the east/central town of Ramapo, is a Jewish community of the Hasidic sect. As such, different religious and cultural considerations will have to be made when developing protective action strategies for this community.

According to the 2000 Census, Rockland County has 286,753 residents. Of that population:

- 76.9 percent are White.
- 11 percent are Black or African American.
- 5.5 percent are Asian.
- 10.2 percent are of Hispanic or Latino origin.

Additionally, 19.1 percent of residents are foreign-born and 9.4 percent are not citizens. More than 29.9 percent speak another language other than English at home; 41.5 percent of which speak English "less than very well." This group represents:

- 47.3 percent of Spanish language speakers,
- 41.3 percent of Indo-European language speakers, and
- 35.9 percent of Asian and Pacific Islander language speakers.

2.2.4 Westchester County Description

Westchester County is 450 square miles in size. The western boundary of Westchester County runs approximately through the center of the Hudson River. The northern border coincides with the southern border of Putnam County, the eastern border coincides with the western border of Connecticut in the north and Long Island Sound in the south and the southern border coincides with the northern border of New York City. Westchester County has 78,242 households and 1,600 businesses within the ten-mile zone. Aside from English, Spanish is the other dominant language.

According to the 2000 Census, Westchester County has 923,459 residents. Of that population:

- 71.3 percent are White.
- 15.6 percent are of Hispanic or Latino origin.
- 14.2 percent are Black or African American.
- 4.5 percent are Asian.

Twenty-two percent of residents are foreign born and 13 percent are not citizens. Twenty-eight percent of the population speaks a language other than English at home, and twelve percent speak English "less than very well." These people represent:

- 51.3 percent of Spanish language speakers,
- 32.3 percent of Indo-European language speakers, and
- 46.7 percent of Asian and Pacific Island language speakers.

Four cities—Yonkers, New Rochelle, Mount Vernon and White Plains—contain 42% of Westchester's population. The southern portion of the County with about 7,940 people per square mile is almost ten times more densely populated than the northern area, which has about 825 people per square mile. Westchester is more densely populated than Suffolk County, Rockland County, Putnam County and Dutchess County.

2.3 Location and Description of Millstone Nuclear Power Station

The Millstone Nuclear Power Station covers approximately 500 acres located on Long Island Sound within the Town of Waterford, Connecticut. The facility is located about 3 miles west-southwest of New London, Connecticut and about 40 miles southeast of Hartford, Connecticut. The Millstone facility currently has two reactors, Unit 2 and Unit 3, both pressurized water reactors, in operation. Unit 1, a boiling water reactor, has been permanently shutdown and de-fueled and is in the process of being decommissioned.

The radiological emergency preparedness plan[3] for the Millstone facility accounts for populations residing in an approximate ten-mile radius surrounding the plant, which is called the plume emergency planning zone. This zone contains the local Connecticut communities of East Lyme, Groton City, Groton Town, Ledyard, Lyme, Montville, New London, Old Lyme, and Waterford. Fishers Island, New York, is also located in the ten-mile area. The Plum Island Animal Disease Center, located within ten miles of the Millstone facility, is a non-residential federal facility. The ten-mile emergency planning zone also contains major industrial facilities, military institutions, and a correctional facility, all of which are located in the State of Connecticut.

Fishers Island, located about 7.5 miles east-southeast of the Millstone facility, is primarily residential with a small year-round population that dramatically increases during the summer months. The peak transient population on Fishers Island typically occurs during the Independence Day weekend. Transient population arrives on Fishers Island by ferry, airplane, or private boats. Fishers Island is a political subdivision of the Town of Southold, New York, which is in Suffolk County on Long Island. Due to a long-standing agreement between Fishers Island, the Town of Southold, Suffolk County, the State of New York, and the State of Connecticut, the responsibility of assessing an initial radiological impact and assistance with implementation of protective actions belongs to the State of Connecticut. Officials of Fishers Island and the Town of Southold have the authority to implement public protective actions. Coordination of the assessment process and resulting protective action recommendations made by the State of Connecticut for Fishers Island and coordination of communications with Suffolk County is performed by the State of New York.

The Plum Island Animal Disease Center is an 800-acre federal facility under control of the United States Department of Agriculture. The island is located within the State of New York, approximately 8.5 miles due south of the Millstone facility. The Plum Island Animal Disease

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[3] *Millstone Power Station Emergency Plan*, Revision 28, Change 4, August 2002.

Center is closed to the public, has no permanent residents, and has a small work force that commutes to the island by ferry. There are extensive facilities, with the centerpiece being negative-pressurized laboratories. Due to the nature of the facility, the Plum Island Animal Disease Center operates independently of local and State jurisdictions. It maintains its own fire and security forces and ferries for the transportation of personnel. The Director of the Plum Island Animal Disease Center will coordinate certain logistical activities with the Town of Southold, the Suffolk County Office of Emergency Preparedness, and the Connecticut Office of Emergency Management.

The ten-mile plume emergency planning zone for this area is depicted in Figure 2-3 below.

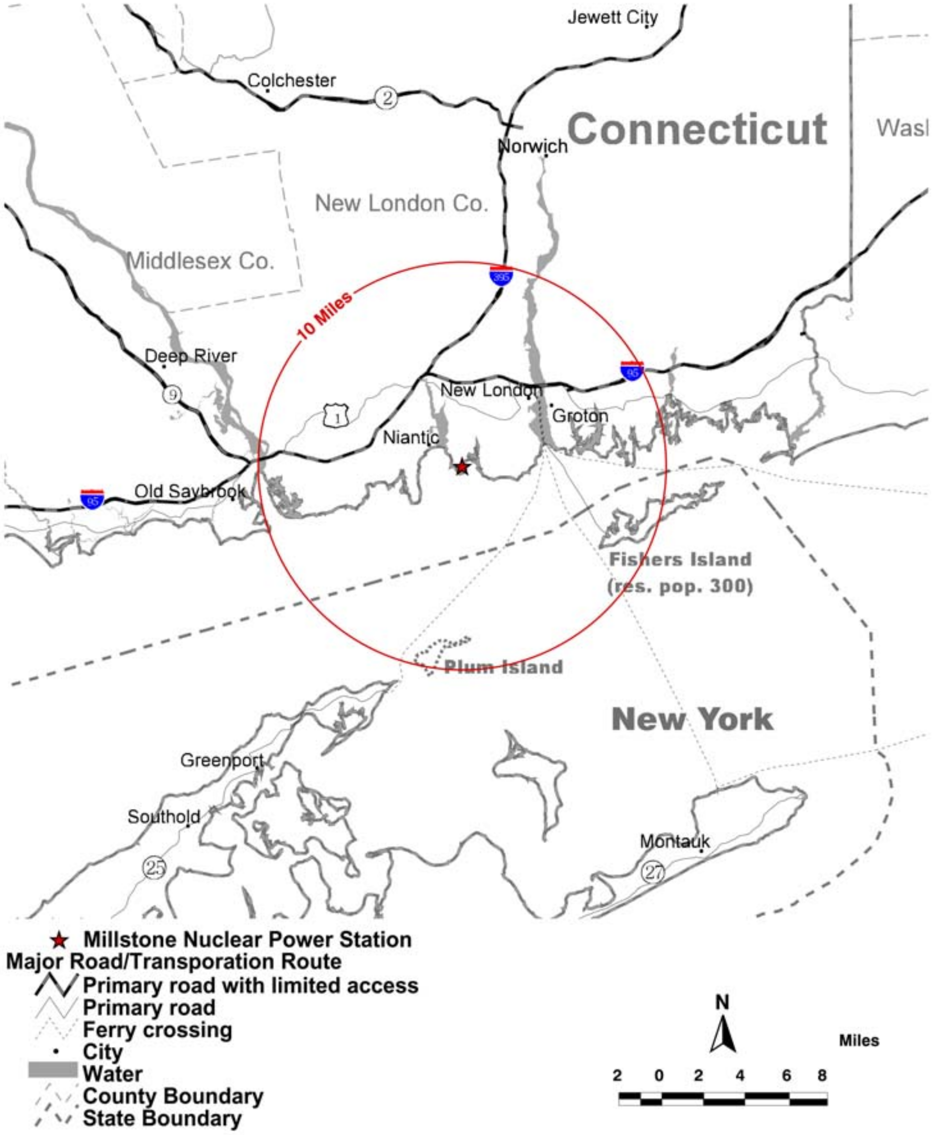


Figure 2-3: Permanent Residential Population in Region Encompassing the Millstone Ten-Mile Emergency Planning Zone

Stretching beyond this region is the 50-mile emergency planning zone (also called the "ingestion" emergency planning zone) which encompasses portions of Connecticut, New York, and Rhode Island. Suffolk County, New York (including part of Long Island) is located in the 50-mile emergency planning zone.

The majority of Suffolk County lies to the southwest of both Fishers Island and Plum Island. The eastern edge of Suffolk County lies closest to the Millstone facility. Summer and weekend populations in Suffolk County are significantly higher than the number of permanent residents.

The ingestion emergency planning zone is depicted in Figure 2-4.

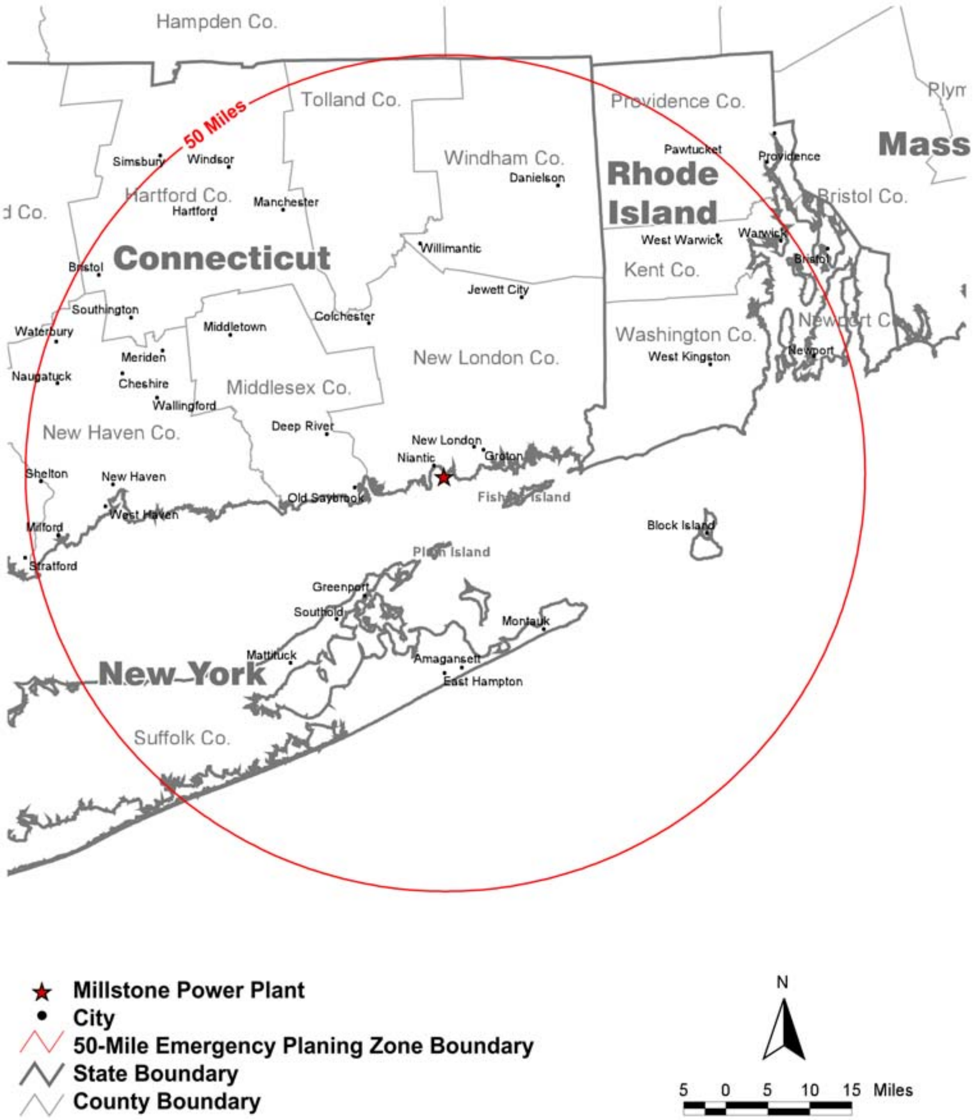


Figure 2-4: Millstone 50-Mile Emergency Planning Zone

2.4 Descriptions and Demographics of the NY County near Millstone Nuclear Power Station

The following outline description of Suffolk County is provided because demographics and other physical attributes are important when developing protective action strategies and effective means of communicating for ethnically, culturally and/or linguistically diverse communities.

2.4.1 Suffolk County

Suffolk County, New York comprises 1,000 square miles of the eastern two-thirds of Long Island. The distance from the Nassau County border to Montauk Point is 86 miles. At Suffolk

County's widest point the distance from Long Island Sound to the southern shore is 26 miles. High tech industries are concentrated in the western portion of the county while the eastern parts of the county are more rural. The county maintains more than 420 miles of roads.

According to the 2000 Census, Suffolk County has 1,419,369 residents. Of that population:

- 84.6 percent are White.
- 6.9 percent are Black or African American.
- 2.4 percent are Asian.
- 10.5 percent are of Hispanic or Latino origin.

Additionally, 11.2 percent of residents are foreign-born and 5.7 percent are not citizens. More than 17 percent speak another language other than English at home; 39.1 percent of which speak English “less than very well.” This group represents:

- 46.6 percent of Spanish language speakers,
- 30.2 percent of Indo-European language speakers, and
- 46.7 percent of Asian and Pacific Islander language speakers.

2.5 The Emergency Management System

In almost every aspect of modern communal life, a number of safeguards exist to prevent serious accidents from happening. For example, there are several measures in place to protect individuals working inside modern office buildings from the threat of a building fire, including building construction codes, smoke detectors, and overhead sprinkler systems. Additionally, many office buildings install security measures, such as access codes, that prevent unauthorized individuals from entering the building and possibly starting a fire, or initiating other types of accidents. Despite these various layers of protection, there remains the possibility that a fire could start, that smoke detectors and sprinklers could fail, and that a large-scale fire could quickly endanger the lives of building occupants. In such a case, the emergency response system becomes the safety measure of last resort. It is critical that this system be effective. In the event that all other measures fail, it is the final safeguard to protect public health and safety.

Likewise, safety at nuclear power plants involves various lines of defense against potential effects on public safety and health. This concept, called “defense-in-depth,” aims to create a succession of safety nets, with the emergency management system as the last net. The NRC recognized this “defense-in-depth” principle in its latest revision to the reactor oversight process.[4]

In 2000, the Nuclear Regulatory Commission revised the reactor oversight process for nuclear power plants to include seven “cornerstones” of safety—initiating events, mitigating systems, barrier integrity, emergency preparedness, occupational radiation safety, public radiation safety, and physical protection. Each layer of defense, or cornerstone, must be as effective and reliable

[4] U.S. Nuclear Regulatory Commission. *Reactor Oversight Process* (NUREG-1649), July 2000.

as possible, but the greatest responsibility lies on emergency preparedness. If an initiating event did occur, and one or more mitigating systems and barriers failed, the emergency response system would be the last safety measure available to protect plant employees and the public from potential exposure to radiation.

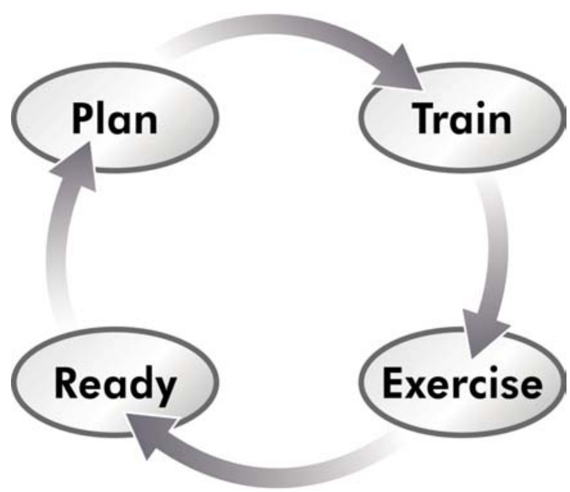
With a sound program of safety practices in other defensive layers, an accident at a nuclear power plant should be unlikely. Regardless, the emergency response system **must** be capable of adequately and effectively protecting people if it is to be the safety measure of last resort.

2.5.1 Planning, Training, Exercising: The Process for Developing and Maintaining an Effective Emergency Management System

An emergency management system is a complex network of people, processes, equipment, and technology. At Indian Point, it involves response agencies at the facility itself, as well as those in the counties of Putnam, Rockland, Orange, and Westchester; the state of New York; and the almost 300,000 residents living in the ten-mile plume emergency planning zone. It includes the plans and procedures these agencies and individuals will use in an emergency, and the vehicles, protective gear, communications systems, warning systems, and other equipment and technologies employed. Each component of this system must be effective, and the entire network must function smoothly together to accomplish its ultimate goal—protection of public safety and health.

The JLWA/IEM team applied the proven framework of Total Quality Management to review emergency preparedness at Indian Point and Millstone. The generally accepted Total Quality Management principles of process reengineering suggest a quality improvement cycle of **Plan**, **Do**, **Check**, and **Act**. Replacing these words with terms more closely correlated to emergency management, the quality improvement cycle for emergency preparedness becomes **Plan**, **Train**, **Exercise**, and **Ready** (Figure 4). "Ready" does not imply that the cycle is complete; rather it is the point where areas needing improvement are being addressed. The cycle is a continuous loop of improvement.

The first step towards developing an emergency management system is planning, which must lead to effective response. In the planning phase, strategies for enhancing public safety and health must be developed and documented in an **implementable** plan. No matter how well written a plan is, it is meaningless if it cannot be smoothly executed, and protect people effectively.



Ease of implementation hinges on five factors:

1. The plan must be **simple** enough for response personnel to implement it quickly, and under stress.
2. The roles and actions of individuals during the response should be **specific** and clear.

3. The plan must be **flexible** enough to allow response personnel to make variations ad hoc, as needed.
4. Responding agencies must **share commitment and common understanding** of the tasks involved.
5. The plan must be capable of **integrating effectively** with the plans of other communities that potentially will respond to an emergency.

The events of September 11, 2001 clarified the need for simple, yet specific, plans. Companies with overly complex disaster recovery plans did not fare as well as those with simpler plans. Finding the relevant information in overly detailed plans presumably took time—time that was unfortunately not available. However, plans that were too simple—providing general guidelines rather than specific directions—put employees in the position of trying to improvise actions in the middle of a disaster of catastrophic proportion. Creating plans that achieve the right balance between simplicity and specificity is one of the challenges faced by emergency planners.

Once the plan is developed, both responders and the public must understand and be trained in their roles and responsibilities. Without training, it is unlikely that responding agencies will trust leadership of their personnel and equipment to people with whom they have had little daily contact, to implement a plan with which they are not familiar. They will continue to use the chain of command they are familiar with, and do what they feel is best to handle the immediate threat. A good training program familiarizes responders with their roles, and also establishes shared commitments and common understanding of the tasks involved, which ensures a more rapid mobilization of response.

We were requested to review public information materials and corresponding public outreach efforts to assess whether the public has the information necessary for effective implementation of the plans, to appreciate the degree of public awareness, to evaluate the extent of public knowledge, and comment on the effectiveness of existing public education and outreach activities. The review of public information included both printed materials and internet resources related to the nature of a possible event, appropriate protective actions, sheltering information, and evacuation instructions. We also considered whether such materials were accessible to those who do not understand English or whose customs make standard approaches ineffective.

In addition to reviewing materials, we were tasked with undertaking our own outreach efforts. Our outreach targeted the general public, especially those populations that have a role in emergency response plans, including those who are critical of the plans, and the populations most affected if the plans should fail. Educating the public on emergency procedures and on other issues related to the hazard are important to the effective implementation of an emergency response. Public confidence in the plans is another important factor in their successful implementation. Recognizing these factors, we considered whether the State and counties' current public education programs effectively provide the public with the information and degree of understanding necessary to effectively participate in an emergency response.

Exercising the plan is critical to assessing its adequacy and effectiveness, especially in determining how long the plan takes to enact. Even the best-laid plans will be ineffective if they cannot be implemented in time to protect the public from being exposed to a critical dosage level of radiation as specified in federal regulations.

Planning, training, and exercising are the building blocks of emergency preparedness. However, for each to be effective, plans, training, and exercises must be based on a thorough understanding of the hazards faced and potential impacts on the public. The following section briefly describes the nature and impacts of hazards associated with nuclear power plants.

CHAPTER 3
DESCRIPTION OF THE HAZARD

The major hazard from a nuclear power plant is a release of radioactive material. In considering the risk of radioactive materials to people, it is important to consider:

- nature and likelihood of a release;
- behavior of a cloud, or *plume*, of radioactive material released;
- effects of radiological exposure to humans;
- Federal guidelines on human dose thresholds.[5]

The effectiveness of the protective actions that are available to the population is directly related to the severity of a threat. A protective action, for example, sheltering-in-place, could dramatically reduce exposure for a small release but not accomplish much dose savings for a larger release. The purpose of the radiological emergency preparedness system is to provide dose savings (and in some cases immediate life savings) for a spectrum of accidents that could produce doses in excess of protective action guides.[6] To understand how doses can be reduced first requires an understanding of how radiation exposure can occur in an accident.

3.1 Nature and Likelihood of a Release

During full-power operation, a nuclear power reactor generates a large amount of radioactivity. Most of this radioactivity consists of fission products produced inside the reactor fuel as a result of the fission process. The fuel effectively contains the radioactive fission products unless it is heated to its melting point. At temperatures in the range of 5,000°F, essentially all the gaseous forms of radioactivity will be released from the fuel. In addition, some of the more volatile forms of the solid fission products may be released as fine aerosols.[7] Either of these forms, if released into the atmosphere, would be spread by prevailing winds.

Design requirements for U.S. nuclear plants mandate that systems be able to contain any radioactivity accidentally released from fuel. Indian Point and Millstone were built using several layers of protection, commonly known as the three-barrier system, the last of which is the containment building, an airtight structure that surrounds the reactor. Both plants employ multiple backup systems for cooling water, electrical power and other key components and functions. In addition, the reactors have a system for removing aerosols from the containment atmosphere.

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[7] There are also federal guidelines for avoiding contamination of plant and animal species.
[6] NUREG-0654, Rev. 1, page 6.
[7] An aerosol is a collection of very small particles or droplets that can travel with the wind for some distance in a plume (cloud), similar to vapors and gases.

The principal goal of reactor safety is to prevent the accidental release of radioactive material. This is addressed through the implementation of systems that lower the chance of accidentally overheating the fuel. There are also back-up systems that prevent the release of radioactivity into the atmosphere even if it were released from the fuel. However, various federal regulations require that plants must still plan thoroughly for radioactive releases. Despite system safeguards and predictions of the types of failures that can occur, unpredicted failures are possible. It is the task of the plant's **probabilistic risk assessment** to identify how a release might happen, to determine how likely a release is to happen, and finally, to determine the public health effects of radioactive releases.

The NRC has established safety goals for all nuclear power plants in the United States relating to risk of prompt fatalities and latent cancer fatalities resulting from potential radioactive releases. Risk as determined by a probabilistic risk assessment (PRA) at each plant is required to be less than or equal to these goals. The goals expressed by the NRC are as follows:

- The NRC safety goal for prompt fatalities is that the risk to an average individual in the vicinity of a nuclear power plant that might result from reactor accidents should not exceed 0.1% of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed. Since the accident risk in the U.S. is about $5x10^{-4}$ per year (another way to express this would be a likelihood of once in two thousand years), this translates to $5x10^{-7}$ per year (or once in two million years).
- The NRC safety goal for latent cancer fatalities is that the risk to the population in the area near a nuclear power plant that might result from plant operation should not exceed 0.1% of the sum of latent cancer fatality risks resulting from all other causes. Since the cancer fatality risk in the U.S. is about $2x10^{-3}$ per year (or once in five hundred years), this translates to $2x10^{-6}$ per year (or once in five hundred thousand years).

The table below provides a comparison of risks from a variety of involuntary causes, including nuclear power plant accidents. These numbers were obtained from material developed for a laboratory training course at Auburn University entitled, "Hazard Evaluation and Risk Assessment."[8]

[8] http://www.auburn.edu/administration/safety/lab_training/2_Hazard%20Evaluation_Risk_Assessments.ppt

Table 3.1: Hazard Evaluation and Risk Assessment

Risk	Risk of Death / Person / Year
Influenza	1 in 5000
Leukemia	1 in 12,500
Struck by Automobile	1 in 20,000
Floods	1 in 455,000
Tornadoes (Midwest)	1 in 455,000
Earthquakes (California)	1 in 588,000
Nuclear Power Plant (typical)	1 in 10,000,000*
Meteorite	1 in 100,000,000,000

Note: This is neither the Indian Point nor Millstone specific risk. We did not have access to specific probabilistic risk assessment (PRA) information for the plants. It is a representative risk number for a typical plant. There are various sources citing values of risk posed by nuclear plants representing a range of values. However, the value provided here is representative of the order of magnitude of the overall individual risk posed from nuclear plants that is available in public domain references.

There are two distinct groups of initiating events that can result in the release of radioactive material from a nuclear plant—accidental and intentional. Accidental initiators, such as mechanical failure or human error, tend to be fairly predictable, while intentional actions, such as acts of terrorism, are not. Both types can result in similar threats to the public if containment is breached and a plume of radioactive material is released into the environment. Regardless of the initiator, local emergency managers must work to prevent exposure of workers and the public to the radioactive material that is released. Plans that are developed and exercised to protect the population against an accidental release can be effective in preparing for an intentional (i.e., terrorist-initiated) release as well.

There may be significant differences in the release characteristics that will drive the type of response required. The most obvious difference is the amount of time available for response. Many accidental release scenarios acknowledge that some amount of warning would be given to the licensee and therefore the surrounding public *before* any radiation escaped the containment area. Accidental events would tend to progress more slowly due to numerous redundant safety systems that fail one after another (sequentially). Radiological emergency preparedness exercise scenarios at Indian Point have traditionally used a scenario that progresses in this fashion. Various stakeholders have postulated accident scenarios (for example terrorist- or sabotage-initiated events) that would progress more rapidly. In such cases, the length of forewarning would be reduced considerably with potential impact on the success of protective action measures. The point here is not to debate the credibility of such rapid escalation scenarios, or the credibility of their specific initiators. The fact remains that rapid onset releases are part of a nuclear plant's planning basis.[9] A rapid release event may have a significantly greater impact on

[9] NUREG 0654 defines an accident planning basis for time to release over a range of 0.5 to 24 hours.

the capability of public to protect themselves and one needs to ask the question "Has such an impact even been considered in planning?" This point is particularly relevant based on our observation that exercises and drills of sufficient scale and participation have not been conducted in the low end of the planning basis for release time factors.

3.2 Plume Behavior

The degree of danger from a plume of radioactive material released from any nuclear plant will depend on the amount and type of materials released into the atmosphere, wind direction, wind speed, terrain, and turbulence in the air.

The primary wind direction in the area surrounding Indian Point is up-valley during daylight hours and down-valley at night. The following graph Figure 3-1 indicates the amount of time the wind blows in each direction. For example, the wind blows towards the south-southwest about 14% of the time and due north about 8% of the time. It is clear from this figure that the river valley will likely have a strong influence on where a plume might go as the wind frequencies strongly follow the bend of the valley.

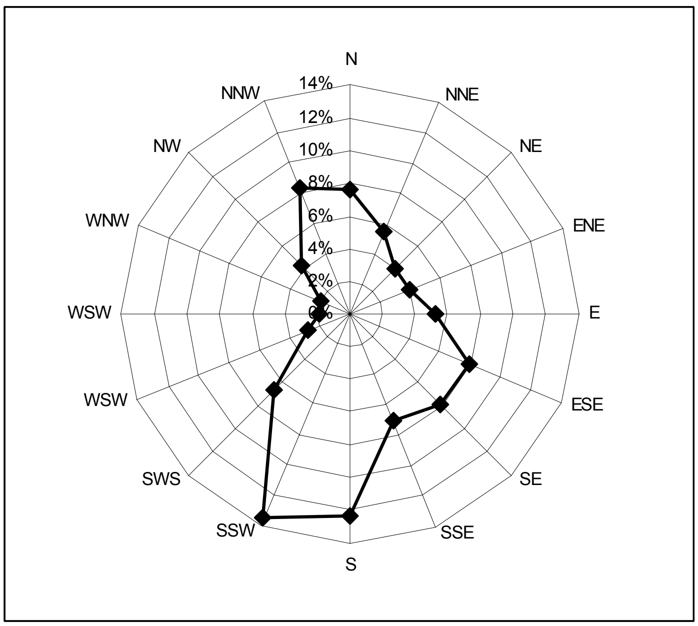

Figure 3-1: Frequency of Wind Direction[10] Around Indian Point

In the area surrounding Indian Point, a low wind speed (less than 4 meters per second or 8.9 miles per hour) results in slow-moving, concentrated plumes that tend to conform more readily to the terrain, bending with the river valley (which is surrounded by 500-1000 foot high ridges). At higher wind speeds (greater than 4 meters per second or 8.9 miles per hour) the plume may move in a nearly straight line away from the release location, largely ignoring the effect of the

[10] The graph shows the frequency with which the wind is blowing “toward” a particular direction, as opposed to the frequency with which it blows "from” that direction.

river valley. Relatively few people live along the bank of the Hudson River. Under low wind conditions, more highly concentrated plumes result but they are confined to the areas along the river and its banks. At higher wind speeds, less concentrated plumes result that can cover more distance and affect more populated areas.

Unlike Indian Point, the Millstone site is not subject to significant channeling of airflow by mountains. However, Millstone is subject to the influence of land-sea circulations. The land-sea breeze circulation is strongest when winds from large-scale weather patterns are weak. Because the only parts of New York State that could be impacted by an accident at Millstone are offshore islands (for the 10-mile emergency planning zone) and Suffolk County/Long Island (for the 50-mile emergency planning zone), the land-sea breeze effects are particularly important for determining doses there. Any dose assessment method that does not include the land-sea breeze circulation will produce questionable results in conditions when the large scale weather patterns have weak winds. Figure 3-2 shows the frequency of the wind direction in the general area around Millstone Power Station.[11] As with the previous figure for Indian Point, this figure shows the percent of the time the wind blows toward a particular direction. When compared to the Indian Point figure, it is obvious that Millstone does not have the same kind of river influence on the wind, as is the tendency in the Indian Point figure.

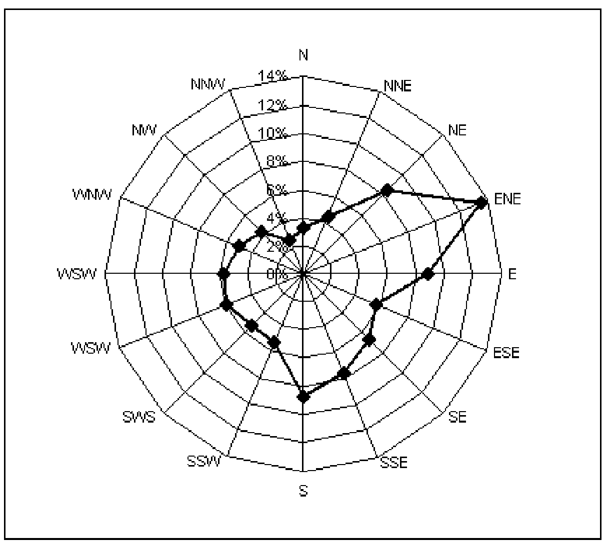

Figure 3-2: Frequency of Wind Direction around Millstone

Turbulence in the air is also a factor in how dangerous a particular plume is. On calm, cool nights, there is little turbulence in the air, the plume is diluted slowly, and the hazard may extend far downwind. On bright, sunny days, there is a lot of turbulence in the air, which dilutes the

[11] In the case of Millstone, IEM did not have access to historical weather observations from the plant itself. This wind data is taken from the closest National Weather Service location with comparable instruments. Based on the relatively close proximity to Millstone, this data should adequately represent the winds in the area of the plant.

plume quickly and prevents the hazard from extending far downwind. Figure 3-3 shows a comparison of two plumes that are identical except for the stability of the wind (turbulence).

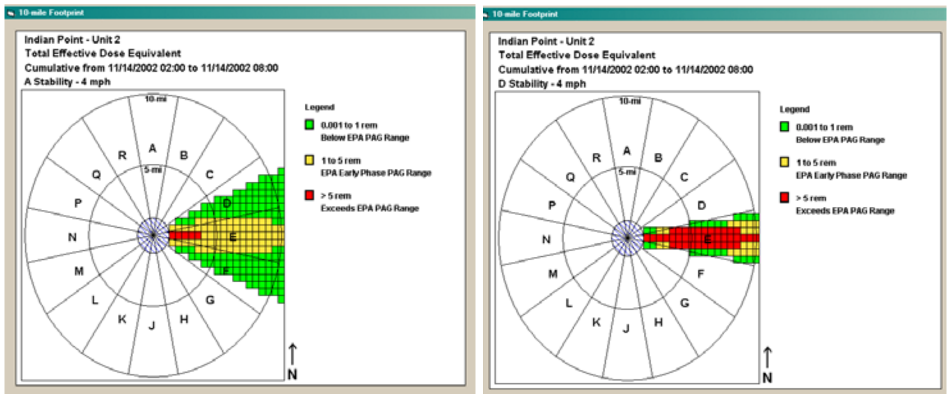

Figure 3-3: Comparison of same plume with more turbulence (left) versus less turbulence (right)

In Figure 3-3, in the two circles the shading in the central right-hand quadrant represents the area covered by the plume. Although the shading in the circle on the left covers more total area, the plume it represents actually poses less of a threat than the one depicted in the circle on the right. Because the same amount of radioactivity is spread out over a larger area in the circle on the left, its effect is diluted. In the circle on the right, the radiation is more concentrated, so individuals in the area covered by the plume could potentially be exposed to a higher dose of radiation.

3.3 Effects on Health

There are three ways a person can be exposed to radiation from a plume. The first, called *cloud shine*, is when radiation from the plume (the cloud) hits a person and damages body cells. The second way is called *ground shine*. Radioactive particles from the plume fall to the ground and emit radiation, to which a passerby can be exposed. The third pathway for radiation exposure is to inhale gas or particles, which are then absorbed by the body or to swallow radioactive particles – radiation can enter the food chain and be absorbed via milk, vegetables or meat products. Certain radioactive chemicals concentrate in specific body organs. For instance, radioactive iodine concentrates in the thyroid gland. Some of these particles can stay in the body for long periods and cause long-term health effects.

Health effects caused by exposure to radiation range from no observable effect to possible death, and include diseases like leukemia or other forms of cancer. Very high,[12] short-term doses of radiation can cause early effects such as vomiting and diarrhea, skin burns, cataracts, and even death. Generally, these very high doses have been limited to the on-site personnel and emergency

[12]Hundreds of rads, where a *rad* is a measure of radiological absorbed dose.

responders at a nuclear plant site during a major event, and on-site personnel at a fuel reprocessing facility.[13]

Persons receiving high radiological doses the first few days after a release (i.e., via early exposure pathways) could experience injuries or death within approximately one year of exposure. Potential delayed health effects that may occur in the exposed population include fatal and non-fatal cancers after varying periods of latency over many years, and various types of genetic effects that may occur in succeeding generations due to radiological exposure of the parents. Both early and chronic exposure could contribute to latent health effects.[14]

Fetuses exposed to high doses of radiation prior to birth have shown an increased risk of mental retardation and other congenital malformations. These effects (with the exception of genetic effects) have been observed in various studies of medical radiologists, uranium miners, radium workers, radiotherapy patients, and people exposed to radiation from the bombing of Hiroshima and Nagasaki. In addition, radiation effects studies with laboratory animals have provided extensive data on radiation-induced health effects, including genetic effects. It is important to note that these kinds of health effects result from *acute exposure* of high doses delivered over a relatively short period of time (as opposed to occupational levels, which are low levels for long periods of time).

3.4 Guidelines on Absorbed Doses and Protective Actions

When developing protective action strategies, several principles need to be clarified for the radiological emergency preparedness program. The Environmental Protection Agency developed four basic principles:[15]

- Acute effects on health should be avoided if possible.
- The risk of delayed effects on health should not exceed the upper bounds that are judged to be adequately protective of public health under emergency conditions, and that are reasonably achievable.
- Protective action guidelines should not be higher than justified on the basis of optimization of cost and the collective risk of effects on health. That is, any reduction of risk to public health achievable at acceptable cost should be carried out.
- Regardless of the above principles, the risk to health from a protective action should not itself exceed the risk to health from the dose that would be avoided. In other words, a

[13]For information on the event at Chernobyl, refer to Goble, Robert L., and Christoph Hohenemser, "Emergency-Planning Lessons from the Accident at Chernobyl." In *Preparing for Nuclear Power Plant Accidents* (Eds. Dominic Golding, Jeanne X. Kasperson, and Roger E. Kasperson.) Westview Press. 1995. Pages 501-517. For information about the criticality event at the Japanese JCO nuclear plant, see Hasegawa, Koichi, and Yuko Takubo, *JCO Criticality Accident and Local Residents: Damages, Symptoms and Changing Attitudes, Data and Analysis of the Results of a Field Survey of Tokai-mura and Naka-machi Residents*. Citizens' Nuclear Information Center, Tokyo, June 2001.
[14] NUREG-1150 volume 2, page A-38, Nuclear Regulatory Commission Office of Nuclear Regulatory Research, December 1990.
[15] Environmental Protection Agency. *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 400-R-92-001) Environmental Protection Agency, Washington, DC. 1992. Pages 2–3

protective action should only be taken if it reduces overall risk, not just the danger due to the radiological threat.

The protective action guidelines developed from these principles are applied to decision-making in different phases of an incident. These guidelines are to be applied to select protective actions. The primary protective actions are evacuation and sheltering. A successful evacuation completed before the radiological plume arrives has the greatest potential to protect public health once a release has occurred. However, it may not be possible to evacuate potentially threatened populations before a plume arrives. In a fast-breaking event, evacuation may still be possible and preferred even though the evacuating people could be exposed to some radiation. In other words, the total dose received would be lower than people would receive if they remained in their homes, office buildings, or businesses. Other conditions might make evacuation impractical. In such cases, because the risk of evacuation would exceed the risk of exposure, sheltering may be the preferred method of protecting a portion of the population threatened by the accident.

Sheltering can provide a substantial amount of protection in situations in which evacuation is potentially a more dangerous option. For example, if a release occurred with very little forewarning, and there is a high degree of uncertainty about the current status of the roads (based, for example, on unusually high traffic due to a special event, or ordinary rush hour), evacuation might be barely feasible. Sheltering might still be the preferred protective action until the roads clear. This is especially true for a short release of radiological material, since sheltering is generally more effective for short-duration plumes.

The Environmental Protection Agency has published general guidance to aid in the decision to shelter or evacuate:[16]

- Wood-frame house (first floor): 10% reduction in dose
- Wood-frame house (basement): 40% reduction in dose
- Masonry house: 40% reduction in dose
- Office or industrial building: 80% or better reduction in dose

Evacuation, under normal circumstances, is recommended when exposure to the public is expected to exceed 1 rem.[17] An analysis completed by the Environmental Protection Agency indicated that the risk avoided is usually larger than the risk incurred by evacuating when exposure to the public is larger than 1 rem.[18]

A rem is a measure of radiation dose used for humans. The rem factors in both the type of radiation and the effect of the radiation on biological tissue. The rem can be expressed in smaller units called millirem. A millerem is one one-thousandth of a rem. Many common exposures to radiation are measured in the smaller units. The important thing to remember is that 1000 millirem add up to 1 rem—the Environmental Protection Agency evacuation guideline.

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[16] EPA 400-R-92-001, pages 2-3.
[17] A rem is a roentgen equivalent man.
[18] EPA 400-R-92-001, pages 2-5.

Figure 3-4 below shows a number of ways humans get exposed to radiation, and the associated millirem values. In a radiological accident, people can potentially be exposed to some number of millirem, or in the case of a larger release, some number of rem.

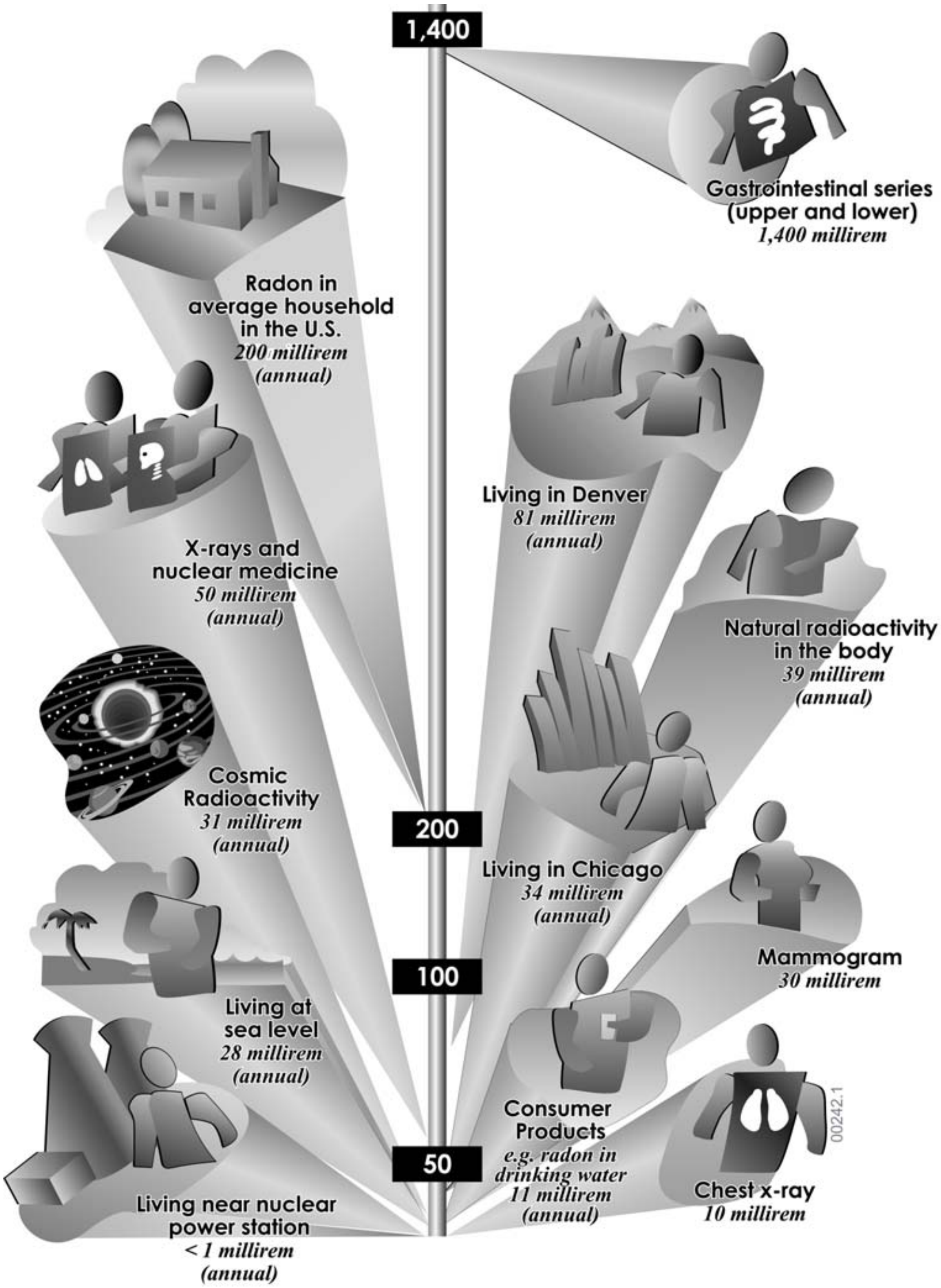

Figure 3-4: Common Sources of Radiation Exposure (Source: US Environmental Protection Agency)

For further comparison, medical diagnoses result in an average of 53 millirem of exposure per year (1/20th of a rem). The average person receives about 360 millirem (1/3 of a rem) every year from natural and man-made radiation. Natural sources of radiation include radon gas, the earth, cosmic rays, and some foods such as bananas, some construction materials. Radon gas is the largest contributor to this average annual radiation—contributing over half of the 360 millirem. Man-made sources of radiation include dental x-rays, medical procedures, and televisions. Voluntary activities such as smoking and air travel also expose people to radiation. The 1/3 rem average is exposure over a whole year. The acute radiation exposure that occurs from an accident is expected to occur over several hours.

The table below shows levels of acute exposure and the corresponding health effects. The standards are based on total dose occurring within a few hours to one whole day. The table also contains two annual exposure values, expressed in terms of per year. These are technically not acute exposure values but they are provided as additional context for the reader in the comparison of the acute values.

Table 3.2: Levels of Acute Exposure and Health Effects as Compared to an Average Annual Exposure Values for Persons in the Unites States

Rem	Whole Body Radiation Dose Effects
1,000	Death occurs within 30 days of exposure in 100 percent of cases
450	50 percent die within 30 days of exposure, if untreated
200	1 percent die within 30 days, if untreated. Five percent suffer nausea
1	Standard for emergency planning and response. EPA recommends evacuating people if the potential exposure is 1 rem or higher.
0.5	EPA Guidance for maximum acceptable dose to the general population from all sources from non-recurring, non-accidental exposure (per year).
0.36	Average annual background levels of radiation per person in the United States

Doses may be chronic or acute depending upon the time of absorbtion.

An acute dose is a relatively large amount of radiation received in a very short time period to the whole body or to one or more areas of the body. Acute doses can cause a pattern of clearly identifiable symptoms or “syndromes”. These conditions are referred to in general as Acute Radiation Syndrome. As in most illnesses, the specific symptoms, the therapy that a doctor might prescribe, and the prospects for recovery vary from one person to another and are generally dependent on the amount and type of radioactivity, the radiation energy, the area of the body exposed, and the age and general health of the individual.

A chronic dose is a relatively small amount of radiation received over a long period of time. The body is better equipped to tolerate a chronic dose than an acute dose. The body has time to repair damage because a smaller percentage of the cells need repair at any given time. The body also has time to replace dead or non-functioning cells with new, healthy cells. This is the type of dose received as occupational exposure.

The research, development, and use of radiation and radioactive materials by man necessarily results in the researchers and users of this technology being exposed to radiation in the course of their work. This is known as occupational radiation exposure. From the earliest days of experimenting with radiation it became known there were levels of exposure at which injury to human tissues could occur. From this acknowledged concern for the safety of radiation workers, regulatory limits were developed based on the type of radiation or radioactive material involved. The following table details occupational exposure limits regulated by two federal agencies.

Table 3.3: Occupational Regulatory Limits (Except for Planned Special Exposures)

	NRC[19]	OSHA[20]
Whole Body (TEDE)	5 rem/year	1.25 rem/quarter
Lens of Eye	15 rem/year	1.25 rem/quarter
Skin	50 rem/year	7.5 rem/quarter
Extremities	50 rem/year	18.75 rem/quarter
Embryo/fetus	500 mrem/gestational period	N/A
Minor	10% of adult	10% of adult<5(N-18) rem lifetime
General Public	100 mrem/year; 2 mrem/hour	N/A

Because the risks of undesirable effects may be greater for young people, individuals under 18 years old are permitted to be exposed to only 10 percent of the adult occupational limits.

Dose Limits represent an acceptable level of potential risk and do not represent a level that will necessarily be unsafe if they are exceeded. Occupational radiation exposure is carefully regulated due to the workers being routinely exposed to radiation and/or radioactive materials, for example a radiographer at a hospital. In addition, there are regulations governing the use of all modalities of x-ray equipment for use in diagnostic procedures, for example dental, mammography and veterinary x-ray, for use on members of the public. It would, however, be impossible to regulate radiation dose limits for members of the public due to the contributions of radiation dose from background radiation, medical administrations, voluntary medical exams, and other sources.

3.5 Off-site Accident Impact Analysis Review

The first steps in protecting the public in the event of a release of radioactive material are to estimate the type and amount of material released and to estimate the off-site areas that will be exposed to potentially harmful doses. This process is called *accident impact analysis*, or *dose assessment* (the two terms are interchangeable). Once accident impact analysis has been done, emergency managers can recommend public evacuation or sheltering in an attempt to reduce the doses received by the public and the consequences of the release.

[19] 10CFR20-Standards for Protection Against Radiation, Subpart C-Occupational Dose Limits, 20.1201-20.1204; Minors, 20.1207, Embryo/Fetus, 20.1208; Subpart D – Dose Limits for Individual Members of the Public, 20.1301.
[20] OSHA Directive CPL 2.86, Memorandum of Understanding Between OSHA and the U.S. Nuclear Regulatory Commission, dated 12/22/89.

In order for emergency management to be effective, accident analysis must accurately determine the area at risk and must be completed quickly, so that a prompt protective action recommendation or protective action decision can be made. The more rapidly the accident is advancing, or the closer the possibility of a release of radioactive material, the more critical timely warning for the site workers and population becomes. Speed is critical so people can start and complete evacuation steps or take shelter before the hazard becomes harmful. At Indian Point, the responding plant staff must issue a protective action recommendation to the off-site jurisdictions within 15 minutes of declaration of a General Emergency condition, regardless of accident initiator and speed of progression.

The decisions made in the early phase (usually considered to be the first four days[21]) are largely dependent on observations made by plant personnel (e.g., "There's a breach to the containment vessel") and computer modeling using current meteorological data and estimates of the source and quantity of radioactive material to project where a plume might be headed. During the intermediate and late phases, decisions would rely more on environmental sampling than modeling, as data becomes available.

IEM reviewed extensive documentation (refer to Appendix B) and consulted with site and state personnel to determine the hazard assessment procedures used at Indian Point and by the State of New York. IEM's review of the Millstone off-site accident impact analysis was primarily based on the plant's detailed administrative procedure. IEM did not specifically review or compare the State of Connecticut's procedures. IEM evaluated all procedures for both completeness and technical soundness, and compared the plans with Nuclear Regulatory Commission standards and state-of-the-art dose assessment methods. Because of the importance of meteorological conditions in determining doses, IEM also evaluated the meteorological data used in the dose assessment. The following sections summarize the analysis and observations. Additional detail is provided in Appendix B.

3.5.1 Review of Off-site Accident Impact Procedures, Indian Point

If there is the potential for a radiological release or a release has occurred, a general set of tasks are performed in an effort to estimate what has happened, how large a release might result and what the impact of that release will be on workers or the population downwind from the accident. Figure 3-5 shows the common set of tasks associated with what is generally termed the *hazard assessment* activity. There is nothing unique about a release of radiation as related to these steps. In other words, the general tasks will be done for a chemical spill, a toxic fire, or a radiological accident. Specifically what is done within each task will vary based on the type accident, the type material and the threat it poses to people or the environment.

[21] EPA 400-R-92-001, pages 4-5.

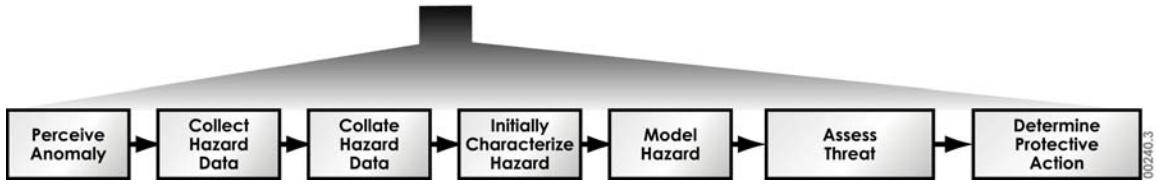

Figure 3-5: Tasks for the Hazard Assessment Activity for Any Accident

The off-site accident impact analysis performed at Indian Point follows this general set of steps. For example, Indian Point can accomplish the Model Hazard and Assess Treat activities via different mechanisms. Under one set of plant conditions there is a predefined set of criteria and a default protective action defined that efeectively results in a protective action recommendation as an outcome of achieving that plant condition. Under other evolving event timelines, dose assessment is performed using plant and weather data and the dose assessment basis described in the rest of this section. The focus of this discussion will be the plant's dose assessment methodology because it can be critical to making and refining protective action recommendations. The terms may be different, but the same fundamental actions are taken. The following text summarizes many of the details associated with the individual tasks performed. For additional specific information on a particular task, refer to Appendix B.

As part of the dose assessment for an accident, Indian Point will estimate the rate of release of radioactive material into the atmosphere. Release rate information is based on monitors located in the pathways where the radioactive material is most likely to escape the plant. Example pathways are the plant vent, the air ejector, the main steam line, and the steam generator blowdown. Noble gas[22] release rates are calculated using the monitor readings in one or more pathways and the rate of flow of air or steam in the pathway. If the flow rate for a pathway is not known, the plant can use previously developed standard values for the pathway. The release rate for radioactive iodine is specifically estimated by assuming a percentage of the overall noble gas release rate. If the monitors are reading off-scale or not providing readings, chemical samples taken in the pathway can be used as a backup. In the case of an event involving the spent fuel pools, FSB ventilation is isolated and rerouted to a monitored pathway.

The release rate can also be estimated based on monitors within the containment building. A release rate from vapor containment can be calculated if the leak area and the vapor containment pressure are known. A release rate can also be estimated using field data (monitoring devices located in or near the radiological plume downwind from the release location). The ability to determine the release rate from field data is important for two reasons. First, it provides a second estimate of the release that can be used to verify the release rate estimated from the monitors in the plant. Second, if the release occurs along an unmonitored pathway in the plant, field data may provide the best information as to the size and rate of the release.

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[22] A noble gas is a gas that is unreactive (inert) or reactive only to a limited extent with other elements.

Release rate calculations can be completed either by hand using the forms located in the Indian Point Emergency Plan Implementing Procedures or by computer, entering the data into the Modular Emergency Assessment and Notification System (MEANS) software located in the plant emergency operations facility. Having two ways to complete the accident assessment is an advantage since it provides a way to cross check results and provides a backup system. In the Indian Point EOF, MEANS is the primary system used to perform the dose assessment. It uses the same information contained in the standard overlays to be discussed, along with meteorological and release rate/monitoring information provided by another computer (MRPDAS). In parallel with the dose assessment at the MEANS computer, the EOF staff can use a map mounted on a light table with a standard plastic overlay containing dose assessment information. The standard overlays are the basis for both the computer and manual dose assessment activity and are described in detail in the following paragraphs.

As an aid in understanding the underlying data assumptions, the description that follows walks through the overlay discussion in terms of selection of a plastic overlay for the map. As stated previously, the use of MEANS does not change the decision criteria for the overlay seletion or the data associated with the overlay—it simply automates the selection,

Indian Point uses a set of 21 map overlays based on different combinations of meteorological information cross-valley overlays and is used regardless of wind direction. This means that for any wind direction at the higher wind speed, the high wind speed overlay is chosen based on atmospheric stability (up- or down-valley winds are not a factor in this case). The overlay chosen is then oriented on the map based on the wind directon at the time. The overlays were originally developed based on wind experiments done in the local area and they have been modified as required over time. The overlays were originally developed, in part, to account for the specific effects of the Hudson River Valley on wind flow in the area around the plant. The dose assessment process begins by selecting the appropriate overlay. The correct overlay depends on the wind speed, wind direction, and the category of atmospheric stability. If the wind speed is greater than 9 miles per hour, an overlay with the correct stability class is selected from the set of cross-valley overlays and is used regardless of the wind direction. The cross-valley overlays are based on the observation that, for higher wind speeds, the terrain has little effect on the airflow. In this case, the overlays show straight-line plumes. If the wind speed is less than 9 miles per hour, the overlay for the correct stability class is selected from the set of up-valley overlays or down-valley overlays, depending on the wind direction. These overlays show the influence of the curving airflow along the Hudson River Valley.

Once the correct overlay has been selected, it is placed on a map of the surrounding area. Each overlay shows isopleths (similar to how elevation contours show on a topographic map) of $\chi U/Q$. This is a mathematical term that is used to scale the concentration of radioactive components in the plume. As one moves farther and farther downwind from the accident or farther from the centerline of the plume, the concentration decreases. The isopleths on the overlay simply represent these changes in concentration for different sets of conditions. For example, the concentration in the plume will decrease more rapidly if there is a large amount of turbulence in the atmosphere; therefore, the $\chi U/Q$ isopleths would be different for an unstable versus a stable atmospheric stability category. When the off-site accident impact analysis is conducted, the overlay that best matches the set of weather conditions is chosen to provide the best estimate of the plume and the concentration scaling factors.

In order to determine the concentration at a point on the map, the hazard analyst notes the value of the isopleth nearest the point, multiplies that value by the strength of the release at the source of the accident, and divides by the wind speed. The resulting number represents the predicted concentration of radioactivity at the point on the map. For example, if the source of the release has a strength measured in Curies per second, the overlay would be applied and the calculation performed to determine the concentration at the point in Curies/m^3 (the average number of Curies in a cubic meter of air). The dose rate in millirem per hour (mrem/hr) is then determined by multiplying by a conversion factor that depends upon the type of radioactive material in the release.

The Modular Emergency Assessment and Notification System (MEANS) is a graphical software application that hazard analysts at Indian Point use to perform the following functions:

- Complete New York State Radiological Emergency Data Forms
- Perform the dose assessment
- Issue protective action recommendations
- Obtain information about emergency action levels

The Dose Assessment and Protective Action Recommendations Module in MEANS is used to perform the dose assessment and to issue protective action recommendations. The emergency manager enters necessary information into dose assessment and protective action recommendation forms, and performs the calculations needed to complete the dose assessment. The dose assessment forms in the computer software mirror the corresponding paper forms that would be used to manually perform the dose assessment. MEANS automatically saves copies of all forms that it transmits, thus ensuring an audit trail.

The MEANS system augments a second computer-based system used in the Indian Point emergency operations facility, the radiological emergency preparedness counties and the State of New York. This system is called the Meteorological, Radiological, and Plant Data Acquisition System (MRPDAS). The MRPDAS is intended to be the means for linking information associated with the predicted dose assessment with all the off-site jurisdictions.

The document *Estimating Total Population Exposure* describes how to determine the doses received by the population. This step is not completed until the recovery phase following the termination of a release of radioactive material.

The dose assessment is made based on wind speed, wind direction, and atmospheric stability averaged over the most recent 15-minute period. If conditions change significantly during the event, the analysis must be repeated using the new conditions. The new plume estimate is based solely on the new conditions and does not include consideration of the fact that the actual atmospheric plume has been influenced by the change in conditions. Thus the dose assessment can have large errors in situations with large shifts in wind direction during the release.

The potential for inaccurate predictions resulting from large wind shifts is not unique to radiological plumes. The same thing can happen when modeling a chemical release or the dispersion of smoke or other particulates. As a general example, Figure 3-6 shows a comparison of chemical plume predictions. In the first case, the plume is initially predicted to go in a straight line; however, there is a wind shift, and a second prediction of the plume is calculated. (The plume predictions are the two feather-shaped objects emanating from the release point.) Note that the second plume prediction is assumed to come from the original source of the release. Between the two predicted plumes is an area that is not accounted for where the actual plume would lie. This is the case described above for the Indian Point prediction (we are just using a chemical plume example to show it here).

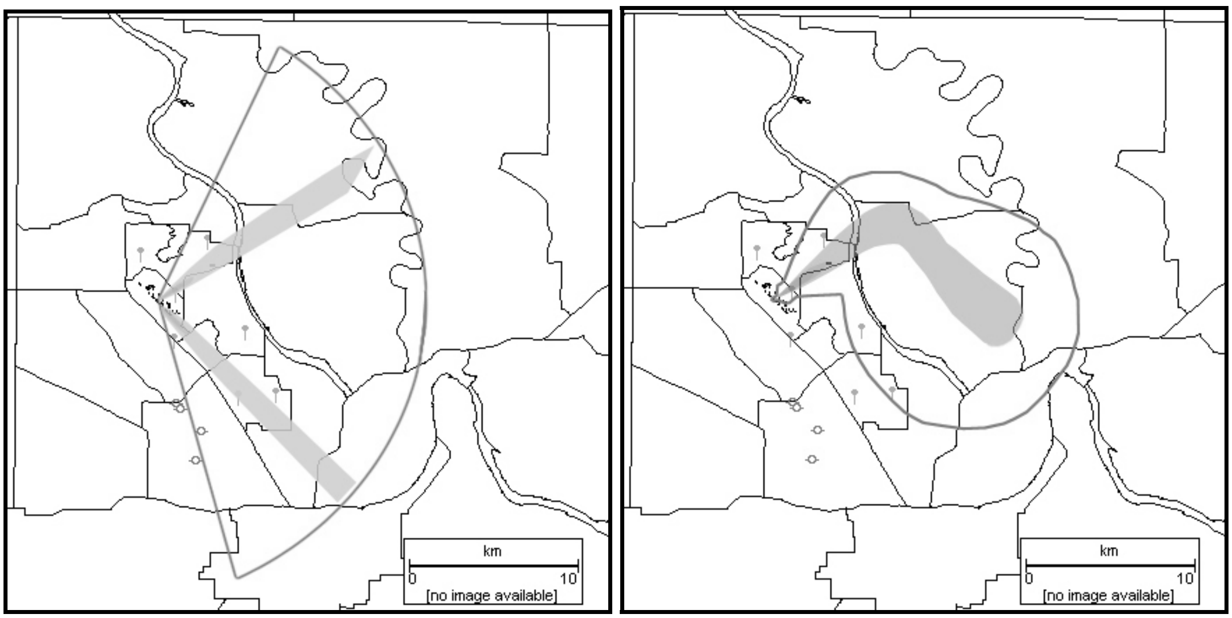

Figure 3-6: Comparison of Wind Shift in Two Different Plume Models

In the second case a different type of model is used that takes the change in the wind into account, as the plume is moving. The plume bends at the point where the wind changed and a more accurate prediction of what the plume is physically doing is obtained. Computer models are available that are connected to multiple weather instruments. These models can produce the second type of plume prediction and are therefore better in the case of a large wind shift when a release has occurred. The fact that the Indian Point procedure could result in the first case is a limitation in their hazard assessment procedure. The problem is far more likely to result when using the high wind speed overlays since at lower wind speeds the plume will tend to follow the river and wind shifts will not affect the plume as much.

It may be argued that the degree of precision allowed by a new model of plume projection is unnecessary because the Counties intend to evacuate all of the areas potentially affected; more precise knowledge of the plume's location would not result in additional protective actions. We believe that more precise information generally leads to better decisions, especially when modern computers and software programs can reduce the problem of information overload.

More precise information may allow better strategies to reduce the dosages of people who have not evacuated. While an evacuation that is broader than necessary errs on the side of safety, it is also true that evacuation of populations not at risk of radiation entails unnecessary costs and other, non-radiation risks to public safety. In addition, plume modeling allows for more precise deployment of field monitoring teams.

The primary source of meteorological data at Indian Point is a 400-foot tower located in the southern corner of Indian Point Energy Center immediately southwest of the IPEC Training Center.[23] This tower has three instrument packages that measure temperature, dew point, wind speed, and wind direction. Precipitation is also measured near ground level. Data are logged at the tower and transmitted by an auto feed to the Emergency Operations Facility by way of landlines and optical fibers for storage on a mainframe computer. The data logger computes atmospheric stability and finds 15-minute averages for use in selecting the appropriate overlay for the accident impact analysis.

A backup source of meteorological data is a tower located approximately 1,200 feet northeast of the primary tower, about halfway between the two power reactors. This tower measures wind speed, wind direction and the variability in the wind direction. The instruments are similar to those on the main tower.

A third set of meteorological instruments is located on the top of the Emergency Operations Facility building. These instruments measure wind speed, wind direction and the variability in the wind direction. The Emergency Operations Facility obstructs the wind flow to these instruments. The turbulence from wind blowing past the building can affect the accuracy of the readings, which makes these instruments more suspect during an event. Data from these instruments are still logged and monitored so they can be used in the event that data from the other two towers are not available.

Power to operate the instruments and data logger is normally supplied by electricity that comes from off-site—not from power generated at Indian Point. If the power fails, a backup battery powers the instruments and data logger. A diesel generator at the tower also provides power as needed. This system is independent of the backup power for the plant and is switched on automatically as needed.

Every six months, the instruments are replaced with newly calibrated instruments, and the old instruments are sent to the manufacturer for recalibration against National Institute of Standards and Technology transfer standards. During the change out, operators also verify that the signal cables and data logger are functioning properly.

The data-monitoring program in the Emergency Operations Facility checks the meteorological data for minimum and maximum values and detects any out-of-bounds values. Emergency

[23] Information on the meteorological data at Indian Point was obtained during a phone conversation between IEM and Entergy on November 1, 2002.

Operations Facility personnel graphically examine the data daily to check for instrument malfunctions.

The protective action recommendation at Indian Point is made using a single observation of 15-minute average wind speed, direction, and atmospheric stability. The Counties may use meteorological forecasts in making their protective action decisions. Forecasts are obtained via the Internet or over the phone through a contract with AccuWeather. Forecasts are used in estimating the hazard location when determining where to send monitoring teams and can be used to project the future hazard location when planning evacuation.

3.5.2 Review of Off-site Accident Impact Procedures, Millstone

The Millstone site can use one of two models, MIDAS (Meteorological Information and Dose Assessment System) and IDA (acronym not known by interviewee at State of Connecticut), to estimate the dose from an accident involving the atmospheric release of radioactive products to the atmosphere. Backup dose assessment can be performed in the absence of the computer models via hand calculations based on Environmental Protection Agency guidance (EPA 400) and standard meteorological tables.

The MIDAS model was developed by ABS Consulting. Based on the Millstone Station Functional Administrative Procedure,[24] the MIDAS model runs on PC workstations connected to a central computer server where the real time meteorological and radiological data are stored. MIDAS calculates doses using a segmented plume model on a fine resolution polar grid with 64 directional sectors and 56 downwind distances out to 50 miles. The use of the segmented plume model allows for variations in meteorological conditions with respect to time. In other words, if the wind shifts during the release the model can calculate the resulting effect on the "shape" of the plume and the changes in downwind dose. Dose assessments are usually calculated using meteorological readings at from instruments placed at multiple elevations on the plant's meteorological tower. By using multiple elevations, the model can account for particular aspects of a sea breeze circulation. MIDAS can also account for the effects of turbulence in building wakes (the turbulent area behind a building as the wind blows over and past it), as well as other complex effects like in-growth, and depositing of radioactive particles on the ground from the plume or via rain interacting with the plume.

The MIDAS model can accommodate 10 design-basis accidents for each operating reactor unit at Millstone. Up to four release locations per unit can be entered into MIDAS. Each release location can have multiple sources of radiation. Calculations are done for each release location separately, and the outcomes are combined to determine the doses in the plume area. The user can enter radiological release data through a variety of methods. The information can be entered automatically (based on the data stored on the central server), manually, via the use of predetermined default values, or via use of preplanned scenario data. Currently, the MIDAS model does not receive meteorological or plant (monitoring instruments) data automatically. So, meteorological and plant information must be entered manually into the model. At some time in

[24] MP-26-EPI-RAP10, Rev. 2

the future, MIDAS may be configured to receive the meteorological and plant monitoring information automatically. The scenario data developed in planning is typically used in drills at the plant. MIDAS can also do back calculations from field monitoring data. The advantages and limitations of the back calculation capability were discussed in the Indian Point review section.

The MIDAS model can display the plume and dose output on a graphical display and in tabular reports. The graphical display is centered on the Millstone plant and includes features such as towns, roads, railroads, and bodies of waters. The user can set "points of interest" on the map and have dose and dose rate information for these points appear on the map display itself. The user can also plot an unlimited number of field measurements on the graphical display. The MIDAS software will also create reports in tabular format that include site specific protective action recommendations.

The IDA model is a tool developed in-house by the Millstone utility. Based on MP-26-EPI-FAP10, the IDA model estimates plume centerline dose assessment and ground deposition values (the amount of particles that are deposited from the plume)). The plume estimates are based on the specific accident conditions (e.g., accident type, release is filtered/unfiltered, containment water sprays where on or off, etc.), and additional inputs like plant monitor data and meteorological data. The basic premise of the tool is to access a database based on the results of RASCAL version 2.1 model runs (RASCAL is discussed in the New York State review section). The accidents used to create the database are a cross-section of generic pressurized water reactor (PWR) and site-specific accidents. The site-specific inputs determine the accident and appropriate RASCAL results to use. The user manually using information from plant monitors or, in the absence of monitoring information, engineering calculations, enters release rate information. Assumptions for various release pathways in the plant were incorporated into IDA to determine the eventual release height of the resulting plume.

In the case of a radiological event at Millstone, the IDA model is used during the early stages as it can provide a quick estimation of the dose with minimal user input. As the event progresses, more refined dose assessments are accomplished using the MIDAS model, which also requires a more advanced user.

To run IDA or manually entered data in MIDAS, the user will need to specify the release rate. The release rate is usually based on monitor readings taken within the main pathways where the radioactive effluent can escape. The main pathways are the site stack, plant vent, the main steam line or the auxiliary feed (Terry Turbine). In addition to the monitor readings, the flow rate for the pathways is required. If the flow rate for a pathway is not known, default values are suggested in MP26-EPI-FAP10, Rev.2. If the monitors are off-scale or not operating, chemical samples taken in the pathway can be used instead of monitor readings. In the case of an event involving the spent fuel rods, FSB ventilation is isolated and rerouted to a monitored pathway.

We did not receive any detailed information about how meteorological data is collected and archived at Millstone station. Based on the Functional Administrative Procedure (MP-26-EPI-FAP10, Rev.002), it appears there is one main tower where wind direction and wind speed are collected at three heights. These correspond to a ground-level release (33 feet), stack release (374 feet), and plant vent release (142 feet). Temperature differences with respect to height are also collected at heights of 142 feet and 374 feet[25]. No information was available as to the specific types of meteorological instruments used, the maintenance procedures for those instruments, the instrument calibration schedule, the source of power or backup power for the instruments, or existence or location of back-up towers.

During an actual event or drill, the Millstone emergency response organization staff faxes dose assessment information to the State of CT using standard forms. If the plant is unable to fax the forms or there is additional information that did not get included on the form, Millstone has two dedicated phone lines between the State and the site that can be used to transmit the information verbally. If the phone lines are down, the State can communicate with the site using a microwave voice link as a final backup alternative.

The dose assessment information flows between the State of Connecticut and the State of New York primarily via a New York State Emergency Management Office representative that acts as a liaison at the Connecticut State emergency operations center. In the absence of the State Emergency Management Office liaison, information is provided to the New York State Emergency Operations Center via fax or voice phone line. This linkage (both with and without liaison) has been tested in practice in the past.

The State of Connecticut provides Millstone emergency action level notification to both Fishers Island and Plum Island via phone as a primary means. Dose assessment information is provided via the same phone links. In the even phone lines fail, the State can communicate directly with Plum Island via specified radio frequencies.

The Millstone licensee and State of Connecticut do not use any time to dose hazard information in making protective action recommendations or decisions. This was the same case for Indian Point. The criteria used for the protective action is "dose avoidance." The criterion is defined as the dose a person would avoid getting via evacuation. It is the difference between the exposure and individual would be projected to get if they stayed in place minus the exposure they would get if they evacuate. Based on the dose avoidance value, a risk versus benefit decision is made to decide whether to issue an evacuation order. The effectiveness of the risk versus benefit decision is therefore very dependent on having accurate, up to date information on the population and the evacuation conditions. Assumptions made concerning evacuation behavior can directly impact the answer. Simplifying assumptions versus reality may significantly impact the effectiveness of the decision. It is not clear in the Millstone review how specifically these issues have been addressed in the context of the protective action decision strategy. The general consensus amongst reviewers for this report, based on the information available, is that these issues require increased scrutiny and that there is current technology available that can help maximize the effectiveness of the decision.

[25] Temperature differences are assumed to be between the height and 33 feet (ground level).

3.5.3 Review of Off-site Accident Impact Procedures, State of New York

Based on the New York State radiological emergency preparedness plan,[26] the State estimates doses at a number of downwind locations from Indian Point. How the doses are calculated is based on the data available from the plant and from other agencies. The State dose methodologies include the Radiological Assessment System for Consequence Analysis (RASCAL) model and the dose assessment methodology used by the Indian Point utility. For an accident at Millstone that might affect population in New York, the State does not duplicate the dose assessment methodology used at Millstone or the State of Connecticut. Thus their results would be different from those produced by Connecticut in the unlikely event Suffolk County needed to deal with them.

The RASCAL model is applicable for estimating doses from an accidental release from a nuclear power plant with some caveats. The RASCAL model was developed for use by the Nuclear Regulatory Commission to conduct independent dose predictions for radiological accidents. It is currently used by the Nuclear Regulatory Commission, the International Atomic Energy Agency, and the North Atlantic Treaty Organization to perform dose assessment. RASCAL can be used to estimate radiological source terms, atmospheric transport, diffusion, and deposition of effluents from the accident, and doses from exposure to the effluents.[27] RASCAL can also estimate doses from environmental measurements of activity in the air or on the ground, and can calculate the decay and ingrowth of radionuclides.

The current version of RASCAL (3.0) is a puff model that takes into account changes in the wind and other atmospheric conditions over time. In other words, it can produce a plume prediction more like the second case discussed in conjunction with Figure 3-6 earlier. RASCAL 3.0 also includes a meteorological processing program that allows the model to take terrain changes (hills, river valley, etc.) into account. Older versions of RASCAL could only do straight-line plume predictions (case 1 from Figure 3-6). The State of New York's plans currently state that it is using one of the older versions (2.2). However, we have been informed that the State has updated to Version 3.0.3, although this has not been verified through documentation. This update will allow the State to better model releases that are affected by terrain, large shifts in the wind direction, or other atmospheric conditions.

If RASCAL cannot be run for some reason, the New York radiological emergency preparedness plan describes other dose-estimating procedures based on the diffusion overlays and base maps provided by the Indian Point. The various methodologies are detailed in Appendix B. All of the State's alternative methods using the overlays and base map appear adequate based on the data available for calculating the dose. However, the last two methods do not take into account the effects of terrain on the travel of the plume.

The New York State radiological emergency preparedness plan also provides two methods for projecting exposure rates, doses, or concentrations from the point of measurement to other

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[26] Procedure H, Assessment and Evaluation.
[27] Sjoreen, A.L., J.V. Ramsdell, Jr, T.J. McKenna, S.A. McGuire, C. Fosmire, and G.F. Athey. *Radiological Assessment System for Consequence Analysis 3.0: Description of Models and Method*" (NUREG-1741) U.S. Nuclear Regulatory Commission, Washington D.C. 2001.

locations of interest. The first method uses diffusion overlays and the base map. It assumes that the ratio of the diffusion at the point of measurement and the point of interest on the map can be multiplied by the dose (or exposure or concentration) at the point of measurement to get the value at the point of interest. This method will generally produce an adequate estimation of the dose, the rate, or the concentration.

The second method uses direct computation that assumes the ratio of doses (exposure rate, concentration) is based on the ratio of the distances downwind from the plant raised to a power that depends upon the atmospheric stability. This should result in reasonable dose estimates during high wind conditions, when the terrain has little effect on the plume. However, it will not provide very good estimates during low winds, when the flow is strongly channeled by the terrain. In those cases, the diffusion overlays and base map would generally result in a better estimate.

As previously mentioned, the State also uses the Meteorological, Radiological, and Plant Data Acquisition System (MRPDAS) for information management of meteorological data and information on the dose assessment. MRPDAS is intended to work as the common tool (the plant, Counties, and State all have it) for capturing and sharing accident-associated information during a radiological event.

3.5.4 Findings from the Off-site Accident Impact Analysis Review

3.5.4.1 Indian Point Off-site Accident Impact Analysis Review Findings

In reviewing dose assessments at other nuclear energy facilities, IEM found that there is no real standard in the nuclear power industry. Many sites use homegrown systems or systems developed by contractors that are not available to the public. Most of these homegrown systems are developed to work directly with the computers on site. The most common model used for dose assessments is the RASCAL model previously discussed. Besides New York, it is used in Arkansas, Mississippi, and Tennessee.

Indian Point estimates release rates using a procedure based on plant parameters that characterizes the level of leakage and a starting core inventory. The level of leakage can be estimated based on monitor readings or sample readings. The use of this procedure seems adequate given the amount of information that will probably be known during an event.

The methodology used to estimate the release at the source from field monitoring data is a potential area of concern. There are a number of assumptions associated with this type of release estimation. One of these is the assumption that meteorological conditions have remained constant from the release of the plume to the time the sample was taken. Depending on wind changes or terrain influences, this assumption may not be true. The method is also very dependent upon the model used to estimate the normalized concentration.

The documentation provided by Indian Point clearly describes the study of the airflow along the Hudson River Valley and explains how the results of that study were combined with dispersion calculations to produce the overlays. The use of the overlays is also well explained. The worksheets used in the dose assessment are organized in a simple format and clearly explain the steps that must be performed. The study, the interpretation of the results, and the use of the results to produce the dose assessment method are based on good scientific principles and sound practices.

The dose assessment and protective action recommendation module in MEANS provides a convenient way for emergency managers to enter necessary data, to make the calculations required to complete a dose assessment, and to transfer the results to forms used in other parts of the emergency management process.

One significant limitation of the overlay technique is that it does not adequately estimate the hazard if the wind speed, wind direction, or stability changes during the release or as the plume moves through the region. Thus the arrival time of the plume at a point downwind from Indian Point cannot be as precisely estimated. Although it was not mentioned in the documents IEM reviewed, the time when exposure to the plume becomes dangerous can be estimated from the calculated dose rate and knowledge of the health effects of various dose levels. This time is called the **dose attainment time** and is important because it determines how much time is available for people to evacuate or to take shelter. Procedures at Indian Point should be revised to consider this time when making protective action recommendations. Plume modeling coupled with modeling of evacuation feasibility can also enhance the protective action decision-making process.

This dose assessment method is based on sound scientific principles and was state-of-the-art when it was developed in the 1970s. Although the calculations made using the overlays and MEANS consider the effects of terrain on air flow, they can sometimes produce poor dose estimates if wind direction shifts during a release. In the last 20 years, there have been significant advances in computer hardware and models for dose assessment. Computer models now exist that are capable of completing the dose assessment process quickly enough to provide useful guidance for determining protective action recommendations. Use of such a model would be superior to the current dose assessment process.

We recommend that the dose assessment process at Indian Point be upgraded to incorporate use of a modern computer model. In order to be of the greatest benefit, the model should have the following traits:

- Be capable of computing dose estimates and displaying maps of the affected areas;
- Include the effects of terrain;
- Include the effects of time changes in meteorological conditions;
- Have a user-friendly graphical user interface designed to allow rapid, error-free entry of necessary data. It should be designed for emergency response use and therefore minimize the number of steps the hazard analyst needs to perform to complete the dose assessment;
- Determine the release rate of radioisotopes based on information that is either obtained automatically from monitors at the site or is readily available and can be quickly entered by the hazard analyst;
- Use meteorological data obtained directly from instruments in the vicinity of the release;

- Be able to use meteorological data forecast by numerical models to predict the future motion of the plume;
- Be capable of estimating the plume arrival time and the time that doses reach hazardous levels;
- Be capable of estimating total population exposure by geographic zone;
- Show results on easily understandable maps and reports and make it possible for the hazard analyst to rapidly disseminate these to surrounding jurisdictions and the State;
- Enable a hazard analyst with a moderate amount of training to enter necessary data and obtain results within a few minutes;

RASCAL Version 3.0 described above has many—but not all—of these capabilities. Also it is worth noting that a dispersion model of this sort would give the best performance if meteorological data were used from a number of locations surrounding Indian Point, rather than limiting the observations to the current set of towers on the facility.

Hazard assessment is the process of understanding the consequences of a release on the environment and surrounding population. Based on this assessment, a margin of safety should be developed to protect the population. For example, there was no mention of plume arrival times for zones for which protective actions were being made in Westchester County. This is a coordination issue since a central point should be generating assessment data and distributing this information along with recommendations. The Indian Point Emergency Operations Facility did provide information in the form of downwind hazard map "sectors" based on wind speed and stability, but the current state-of-the-art technology far exceeds this process.

There exists a communication problem with the dose assessment as well, since there is not an automated way of communicating assessment data in the region. Although such data is generated automatically using the Modular Emergency Assessment and Notification System (MEANS) described previously, it is currently being manually faxed after the dose assessment is initially performed. For example, during this year's full scale exercise, Indian Point personnel tried to use their fax machine to send assessment information to the Counties, but the group dialing feature didn't work; instead, the dialing had to be done manually—jurisdiction by jurisdiction. It was further observed that some of the county phone numbers were not current when the individual dialups were attempted. A final issue with automation included the initial failure of the MRPDAS to function correctly during the full-scale exercise, although it eventually worked well into the exercise.

Generally, it appeared that the assessment used was not integrated at a sufficient level with the protective action decision-making. There exists technology now that would greatly facilitate this process with features such as graphical overlay of the plume on maps, real time update of plume location and status, and integration of health effects information with the plume projection data. This would allow the decision-makers the ability to visualize how the situation could play out as well as help communicate the situation to other important parties (elected officials, public information officers, etc.) rapidly and effectively. The significant issues with this aspect of the emergency response are related to **communication**.

The meteorological data are collected at the Indian Point site and are therefore appropriate for determining the initial direction that a radionuclide cloud would travel if released from Indian Point. The instruments on the tower are rugged and capable of withstanding adverse weather. Maintenance procedures at the plant ensure that they are kept in operating order and in calibration. There is adequate redundancy in the number of instrument towers, in the power supply to the instruments, and in the data transmission to the Emergency Operations Facility. Even if all on-site data are not available due to a large-scale event or deliberate disruption, off-site data can be obtained and should be adequate for use in the dose estimation. In this case, the dose estimate will involve larger uncertainties than when on-site data is used. Meteorological forecasts are available for use in predicting plume motion. IEM believes this instrumentation is sufficient and appropriate for use with the impact assessment procedures currently used at Indian Point. As previously noted, additional meteorological data will be needed if a state-of-the-art dispersion model is adopted for dose assessment.

3.5.4.2 State of New York Dose Assessment Plan Review Findings

The documentation provided by New York State presents the various methods the State would use to perform dose assessment. The use of the RASCAL model is valid, as the model was built for the Nuclear Regulatory Commission for the purpose of dose assessment. RASCAL version 2.2 is somewhat limited in that it does not take into account the effects of terrain. The transition to RASCAL 3.0 by the State solves the limitations of RASCAL 2.2 regarding the effects of terrain, which could be significant at the Indian Point site.

All of their methods using the overlays and base map are functional based on the data available for calculating the dose, even though significant room for improvement exists. However, the methods involving knowing the nuclide concentration do not take into account the effects of terrain on the travel of the plume. This information is important for the estimation of the exposure of the evacuating public. It is also necessary to estimate the distance of significant dosage levels.

CHAPTER 4
REVIEW OF EMERGENCY PLANS: COMPLIANCE WITH REGULATIONS

Radiological emergency preparedness plans are an integral part of the emergency response system safety net in the "defense-in-depth" strategy discussed previously in this report. The purpose of these plans is to protect the health and safety of the general public in the event of a radiological incident at nuclear energy facilities.

Radiological emergency preparedness plans are similar to business plans in that they provide a system and structure to enable success. Each response procedure in the planning documents is designed according to the threat level or type of event that could occur at a nuclear facility. The plans address many issues, such as evacuation time estimates, maximum acceptable exposure levels of radiation, evacuation or shelter-in-place protocol, and decontamination procedures for exposed individuals or property.

Radiological emergency preparedness plans follow a specific format. They include an overview of responses that need to occur during an event as well as an in-depth description of specific response procedures. Descriptions of preparedness, response, and recovery phases for events as well as written agreements (or descriptions of agreements) between various organizations that fill emergency response roles are included in the plans. Individual task responsibilities during a response are also specified in the documents. A plan is considered unsound if individuals critical to response efforts do not know their specific responsibilities.

Emergency plans are living documents that require consistent updating to reflect the current emergency preparedness status of a jurisdiction. Because emergencies are not predictable, plans must always be updated and ready for implementation. Updates include details such as current contact information for emergency response personnel.

Experienced members of the James Lee Witt Associates team reviewed plans for Indian Point,[28] Millstone,[29] and associated jurisdictions to determine their regulatory compliance with planning criteria from the Nuclear Regulatory Commission, FEMA, and the Environmental Protection Agency.[30] These organizations have statutory authority for public safety in the event of a radiological release from a United States nuclear facility.

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[28]IEM reviewed the following plans: *Indian Point Energy Center Emergency Plan Draft*, revised February 2001; *New York State Radiological Emergency Preparedness Plan for Commercial Nuclear Power Plants*, 2001; *Putnam County Radiological Emergency Response Plan*, revised April 2002; *Rockland County Radiological Emergency Plan*, revised May 2002; *Orange County Radiological Emergency Response Plan*, revised June 2002; and *Westchester County Radiological Emergency Plan for the Indian Point Energy Center*, 2002.

[29]IEM reviewed the following plans: *Millstone Power Station Emergency Plan*, revision 28, change 4, August 2002; *State of Connecticut Radiological Emergency Response Plan*, revised December 1999; *Suffolk County Hurricane/Coastal Storm Emergency Response Plan*, revised May 30, 2002; *Fishers Island Radiological Emergency Response Procedures*, revised December 1999.

[30]U.S. Nuclear Regulatory Commission and Federal Emergency Management Agency. *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); Environmental Protection Agency. Manual *of Protection Action Guides and Protective Actions for Nuclear Incidents*, revised 1991.

In performing this phase of the evaluation, reviewers used as a primary filter compliance with the applicable regulation(s). Each item in the review was graded as "Met" or "Not Met" in light of the applicable standard. In some cases, the plan might have fulfilled the letter of the regulation and was graded as having "Met" the requirement, but the reviewer included a comment concerning how the observed system or process might be improved to enhance emergency preparedness.

The findings of the review for all six organizations evaluated tend to fall into three principal categories:

1. Missing discussion or details about required issues that could impact public safety and the effectiveness of response
2. Information that is asserted in the plan to be contained in other appendices which were not provided to the reviewer, and therefore could not be verified
3. Information that is contained somewhere other than in the place or the format specified by the applicable regulation (including in separate documents maintained by the organization that are not part of the official plan—for instance, in the Implementing Procedures)

The items in the first group are obviously the cause for most concern and should be rigorously followed up to ensure remedy or clarification. The lack of critical information or defined processes can significantly impact the effectiveness of a response.

In response to additional feedback provided by planners in the Indian Point REP jurisdictions, the JLWA team confirmed that many items identified in the draft version of this report as “Not Met” were in fact located in appendices or implementing procedures. These appendices and procedures had either not been available to the plan reviewer during the limited time window for the review, or had been updated subsequent to the review or publication of the draft report. Such updates are acceptable based on our previous statement that emergency plans are “living documents.” Much of the plan and associated document confirmation was accomplished in a follow-up visit to the Indian Point Energy Center Emergency Operations Facility in February 2003.[31] Where subsequent reviewers obtained sufficient evidence for a change in a plan compliance item status, the item was either reclassified as “Met” and removed from the applicable Appendix C table, or a comment was added in the table. In the event a comment was added, the associated status may or may not have changed.

Of course, further analysis could reveal that many of those items actually fall into the other two categories—e.g., a piece of missing critical information that is captured elsewhere in the organization’s knowledge base or operational processes and would be activated in a response. This still represents a potential major weakness in the system if the existence or location of a particular piece of information is not generally known or is “filed” only in one person’s head.

[31] The February review focused on a final consolidated IPEC Emergency Plan dated August 29, 2002.

In a number of cases, the information called for in the requirement was known or strongly suspected by the reviewer to be available within the organization, bound under separate cover from the plan. However, if the information was missing from the physical plan document, the reviewer applied a strict interpretation of NUREG-0654 and marked the item as “Not Met.” During follow-up plan reviews, reviewers provided with additional content made a judgment as to the availability of information published separately from the emergency plan document. In other words, the reviewers made their decisions based on whether the information would be reasonably available to all who needed it prior to or during a response, even though the information was not in the more commonly distributed and shared plan. Subsequent reviewers remained sensitive to items with limited access, or items for which organizational knowledge appeared to reside with single persons—conditions that would indicate weaknesses in the planning process and organizational preparedness.

In a number of cases, the information called for in the requirement was known or strongly suspected by the reviewer to be available within the organization, bound under separate cover from the plan. However, the absence of this information from the physical plan required the reviewer to grade the requirement as "Not Met" according to a strict interpretation of NUREG-0654. This information includes such elements as inventories, organizational charts, resource lists, and letters of agreement.

Millstone Station presented a special challenge: the copy of the licensee plan provided for review was missing several key sections, including all the Appendices. Because it was strongly suspected that much of the missing information is contained in the missing sections, the reviewer opted to mark a large number of items as "Unknown" as opposed to "Not Met." A follow-up review with a complete section of the Millstone plan is highly recommended.

In addition, the Fishers Island plan provided for review seemed to be focused on operational aspects (primarily checklists), and provided very few details related to pre-planning and mitigation measures. For this reason, the plan was necessarily judged to have "Not Met" many of the formal requirements. The Suffolk County plan does not address radiological emergency preparedness; the primary hazard it addresses is hurricanes. Therefore, reviewers did not complete a radiological emergency preparedness compliance matrix for the Suffolk County plan.

In addition, throughout the plans, there are varying degrees of non-compliance. For instance, a section of a plan might treat four of five elements specified by one particular requirement in NUREG-0654. In that case, the plan was deemed to have "Not Met" the particular requirement, though in truth the plan was 80% in compliance for that line item. In other cases, the plan might contain no mention of the required item.

Many of the findings that fall in the second and third groups require primarily bookkeeping or document reorganization to bring the plan into compliance. In fact, formal integration of information contained in a number of the Implementing Procedures into the respective plan documents could well remedy the vast majority of non-fulfilled requirements from all three groups. However, while mere inclusion would technically bring the plans into compliance, it could make them too detailed or bulky to be effective during a response without a clear and effective organization scheme. As was mentioned in Section 2.3, this is the dilemma faced by planners.

A summary of potentially significant findings for each organization appears in the following sub-sections. Individual plan review matrices are included in Appendix C.

4.1 Review of Indian Point Plans

4.1.1 Indian Point Energy Center Plan Review

The Indian Point compliance review matrix is Table 1 in Appendix C. Following is a discussion of some of the more significant issues noted by the reviewer. (The regulation is stated first in italics, followed by the reviewer's comment.)

- *II.G.2—The public information program shall provide the permanent and transient adult population within the plume exposure EPZ an adequate opportunity to become aware of the information annually. The programs should include provision for written material that is likely to be available in a residence during an emergency. Updated information shall be disseminated at least annually. Signs or other measures shall also be used to disseminate to any transient population within the plume exposure pathway EPZ, appropriate information that would be helpful if an emergency or accident occurs. Such notices should refer the transient to the telephone directory or other source of local emergency information and guide the visitor to appropriate radio and television frequencies.*

  There are indications that the 2001 public emergency planning booklet missed a significant portion of the permanent population. County booklets are not available on an Indian Point Emergency Center website, though they are available on the Westchester County website. According to Indian Point emergency preparedness personnel, school programs are not used to reaching parents through their children. Few signs have been posted yet for transients. A coordinated program exists to inform the large population that commutes into the 10-mile emergency planning zone to work; however, there is no evidence yet that this program has been implemented. These are all critical issues for ensuring that the public is kept at a safe distance and can quickly evacuate from the emergency planning zone during an emergency. It appears that Entergy is making appropriate efforts in this area with regard to aspects within their control, but as noted by Entergy, improvements are needed.

- *II.N.2.a—Communications with State/Local governments within the plume exposure pathway EPZ shall be tested monthly. Communications with Federal ER organizations and States within the ingestion pathway shall be tested quarterly. Communications between the nuclear facility, state and local EOC's and field assessment teams shall be tested annually. Communication drills shall also include the aspect of understanding the content of the messages.*

There is no mention in the plan of testing communication with any other states in the 50-mile ingestion pathway. Since these states could be involved in an event, the modes of communication should be tested to ensure that critical notifications will reach the appropriate personnel in a timely and effective manner.

The NY State Radiological Emergency Response Plan (dated February 2001), Procedure F, Section 2.3 addressed quarterly testing of communications links with other States within the ingestion pathway, but this requirement in NUREG-0654 is noted as applicable to plant plans. As this requirement is not discussed at all in the IPEC Emergency Plan, it is still not met for the plant plan. However, it does not represent a significant public health and safety issue

It is recommended that Entergy modify the IPEC Emergency Plan, in coordination with NY SEMO, to note that the State performs the communications drill to meet this requirement.

4.1.2 New York State Plan Review

The State of New York compliance review matrix is Table 2 in Appendix C. Following is a discussion of one of the more significant issues noted by the reviewer.

- *All Protective Action Guidelines should be consistent for all of the population*.

  Protective action guidelines are consistent for most of the population; however, prisons and prisoner considerations are not met. Issues related to special populations (such as moving and housing inmates) should be clearly identified prior to an event because they require extra time and attention to implement during an emergency.

4.1.3 Putnam County Plan Review

The Putnam County compliance review matrix is Table 3 in Appendix C. There were only ten review items summarized there—none of which in the final review analysis were judged to represent issues with potential public safety significance.

4.1.4 Rockland County Plan Review

The Rockland County compliance review matrix is Table 4 in Appendix C. Following is a discussion of a significant issue noted by the reviewer.

- *II.H.10—Each organization shall make provisions to inspect, inventory, and operationally check emergency equipment/instruments at least once each calendar quarter and after each use*.

  The plan includes a list of equipment and mentions that equipment should be checked "upon receipt, before and after each use, and within each calendar year thereafter." This is insufficient because the requirement is for a complete equipment inspection at least once every calendar quarter. Noncompliance with this requirement could lead to a situation in which mission-critical equipment is missing or inoperable when most needed in an emergency response.

4.1.5 Orange County Plan Review

The Orange County plan did not meet several of the regulation criteria; however, these issues were not considered to represent a significant threat to public health and therefore are not mentioned in this section. The Orange County compliance review matrix is Table 5 in Appendix C.

4.1.6 Westchester County Plan Review

The Westchester County compliance review matrix is Table 6 in Appendix C. Following is a discussion of some of the more significant issues noted by the reviewer. (The regulation is stated first in italic, followed by the reviewer's comment.)

- *II.J.2, Each licensee shall make provisions for evacuation routes and transportation for on-site individuals to some suitable off-site location, including alternatives for inclement weather, high traffic density, and specific radiological conditions. This requirement helps ensure coordination between on-site and off-site response actions, identification of impact of on-site evacuation on evacuation routes, and identification of possible media attention and ripple effects of an on-site evacuation*.

  The plan acknowledges that on-site evacuation is the licensee's responsibility which technically meets the requirement of NUREG-0654. However, the plan should include provisions to account for the effect of evacuation of on-site personnel through the County's evacuation network, possibly along with the general population.

- *II.J.12, Each organization shall describe the means for registering and monitoring of evacuees at relocation centers in host areas. The personnel and equipment available should be capable of monitoring within about a 12-hour period all residents and transients in the plume exposure EPZ arriving at relocation centers.*

  This requirement is not met in the plan or any of the radiological emergency preparedness procedures, although it is possible that it may be addressed in another plan or in the "Rad Field Monitoring Manual" that is referenced but not provided. There is no evidence that calculations were completed to determine the resources necessary to monitor all evacuees within 12 hours. Based on the documents submitted, it is not possible to determine what capabilities exist for monitoring and decontamination of evacuees at relocation centers.

4.2 Review of Millstone Plans

Results of the review of the Millstone Station plan and those of the associated State and local jurisdictions are discussed below. New York authorities consider Connecticut's plan for Fishers Island to be adequate for assurance of the safety of the population at risk. New York considers its own plan adequate to address its responsibilities for public safety problems arising from a Millstone event and occurring on the fringe but outside of the 10-mile emergency planning zone.

4.2.1 Millstone Plant Plan Review

The Millstone Plant compliance review matrix is in Appendix C. Following is a discussion of some of the more significant issues noted by the reviewer.

- *II.H.7 – Each organization, where appropriate, shall provide for off-site radiological monitoring equipment in the vicinity of the nuclear facility.*

  No discussion appears in the appropriate sections of the plan regarding whether the licensee has installed off-site radiological monitoring equipment in the vicinity of the nuclear facility.

- *II.J.2 – Each licensee shall make provisions for evacuation routes and transportation for on-site individuals to some suitable off-site location, including alternatives for inclement weather, high traffic density and specific radiological conditions.*

  Evacuation of on-site individuals is discussed in the plan. No specific discussion is provided regarding evacuation routes or alternatives for various adverse conditions. There is a discussion regarding the use of sheltering-in-place if the hazard will be short-lived or if the safety of the evacuation population would be threatened. Procedure MP-26-EPI-FAP06 states "Station personnel do not typically have the necessary information to determine whether off-site conditions would require sheltering instead of evacuation. Therefore, an effort to base [public action recommendations (PARs)] on external factors (such as road conditions, traffic/traffic control, weather, or off-site emergency worker response) should not be attempted." This is information that licensee personnel should maintain an awareness of in coordination with off-site organizations.

- *II.J.8 – Each licensee's plan shall contain time estimates for evacuation within the plume exposure EPZ. These shall be in accordance with Appendix 4.*

  Not evaluated. No mention of evacuation time estimates appears in the copy of the plan provided for review. However, MP-26-EPI-FAP06 ("Classification and PARs"), which was provided for review, does not indicate that the ETEs were used by the licensee in making protective action recommendations.

- *II.J.10 – The organization's plans to implement protective measures for the plume exposure pathway shall include:*

- *Maps showing evacuation routes, evacuation areas, pre-selected radiological sampling and monitoring points, relocation centers in host areas, and shelter areas*
- *Maps showing population distribution around the nuclear facility. This shall also be by evacuation areas (licensees shall also present the information in a sector format)*
- *Means for notifying all segments of the transient and resident population*

Except for the means of notifying the resident population, the copy of the plan provided for review does not contain this level of information. It may be provided in parts of the plan unavailable in the review copy or in plant procedures. However, this information is not included in the copy of MP-26-EPI-FAP06, "Classification and PARs" that was provided for review.

- *II.J.10.m – Bases for the choice of recommended protective actions from the plume exposure pathway during emergency conditions. This shall include expected local protection afforded in residential units or other shelter for direct and inhalation exposure, as well as evacuation time estimates.*

  The bases for choosing protective action recommendations (PARs), expected local protection afforded by sheltering, and evacuation time estimates are not provided in the plan. Additionally the copy of MP-26-EPI-FAP06, "Classification and PARs" provided for review does not contain this information.

- *II.A.3 – Written agreements between various organizations with emergency response roles are included in the plan or the plan includes descriptions of these matters.*

  The plan notes that arrangements have been made with several organizations, e.g. Haddam Neck Plant (backup decontamination), local community ambulance services (medical transportation), Middlesex Hospital and Lawrence & Memorial Hospital (Medical Treatment). However, there is little detail of the arrangements and no copies of written agreements in the copy of the plan provided for review. Also, note that Haddam Neck Plant ceased operations in December 1996. While it may retain capability to provide backup support to Millstone, if such capability has not been recently verified and agreements to do so have not been recently reviewed, this should be done.

- *II.E.3 – Contents of initial emergency messages to be sent from the plant have been established with State and Local organizations. It shall include information about:*
  - *Class of emergency*
  - *Whether a release is taking place*
  - *Potentially affect population/areas*
  - *Whether protective measures may be necessary*

The plan does not specify that information regarding potentially affected populations/areas is transmitted via the Emergency Response Notification System (ERNS). The Nuclear Incident Report Form (MP-26-EPI-FAP07-001) includes information on the class of emergency and whether a release is taking place. It does not include information on potentially affected populations (by zone or otherwise) or whether protective measures may be necessary. It does include wind direction information.

- *II.E.4 – Each licensee shall make provisions for follow-up messages from the facility to off-site authorities which shall contain the following information if it is known or appropriate:*

  - *Location of incident and name and telephone number of caller*
  - *Date/time of incident*
  - *Class of emergency*
  - *Type of release, expected duration*
  - *Estimated quantity of radioactive material released, points, height of release*
  - *Chemical and physical form of released material, including relative quantities and concentration of noble gases, particulates, and iodines.*
  - *Met conditions at appropriate levels*
  - *Dose rates and integrated dose projection at site boundary*
  - *Projected dose rates and integrated dose at the projected peak and at 2, 5, and 10 miles, including sectors affected.*
  - *Estimate of any surface radioactive contamination inplant, on-site, or off-site.*
  - *Licensee emergency response actions underway.*
  - *Recommended emergency actions, including protective actions*
  - *Request for any needed on-site support by off-site organizations*
  - *Prognosis for worsening or termination of event based on plant information.*

The plan does not specify the content of follow-up messages to the appropriate level of detail described here. The Nuclear Incident Report Form (MP-26-EPI-FAP07-001) includes information only on the following items:

  - Location of incident and name and telephone number of caller
  - Date/time of incident
  - Class of emergency
  - Met conditions at appropriate levels
  - Request for any needed on-site support by off-site organizations
  - Prognosis for worsening or termination of event based on plant information.

- *II.E.7 – Draft messages to the public giving instructions with regard to specific protective actions to be taken by occupants of affected areas shall be prepared and included as part of the State and Local plans. Such messages should include the appropriate aspects of sheltering, ad hoc respiratory protection (handkerchief over mouth, etc.) thyroid blocking, or evacuation.*

  The plan does not include a discussion of the preparation or content of draft messages to facilitate instructions to the public during an event.

- *II.G.4 – A spokesperson is designated who should have access to all necessary information. Arrangements are established for timely exchange of information among designated spokespersons. Coordinated rumor control processes have been established.*

  The Executive Spokesperson (ES) is the designated licensee spokesperson. Information exchange is coordinated with the Nuclear News Manager (NMM). A Rumor Control Liaison (RCL) position is discussed, but no mention is made in the plan of established rumor control processes, although the issue is discussed in the State plan.

- *II.I.1 – Each licensee shall identify plant system and effluent parameter values characteristic of a spectrum of off-normal conditions and accident, and shall identify the plant parameter values or other information which correspond to the example initiating conditions of Appendix 1. Such parameter values and the corresponding emergency class shall be included in the appropriate facility emergency procedures. Facility emergency procedures shall specify the kinds of instruments being used and their capabilities.*

  Not Evaluated. The attachments to Procedure MP-26-EPI-FAP06, "Classification and PARs" containing the emergency action level tables were not available in the copy of the procedure provided for review, so compliance could not be verified.

- *II.J.1 – Each licensee shall establish the means and time required to warn or advise on-site individuals and individuals who may be in areas controlled by the operator, including:*

  - *Employees not having emergency assignments*
  - *Visitors*
  - *Contractor and construction personnel, and*
  - *Other persons who may be in the public access areas on or passing through the site or within the owner controlled area*

  The plan notes that radiation alarms, public address system, pager system, and the station emergency alarm are used for notification. The plan does not discuss the time required to warn all on-site personnel by one or more of these means.

4.2.2 State of Connecticut Plan Review

The State of Connecticut compliance review matrix is in Appendix C. Following is a discussion of some of the more significant issues noted by the reviewer.

- *II.A.3 – Written agreements between various organizations with emergency response roles are included in the plan or the plan includes descriptions of these matters.*

  There is no mention of any type of written agreement between various organizations in the plan.

- *II.E.2 – Procedures have been established for alerting, notifying, and mobilizing emergency response personnel.*

  In section 1.0 Concept of Operations there is mention of alerting and mobilizing emergency personnel. However, the procedures are not included.

- *II.G.2 – The public information program shall provide the permanent and transient adult population within the plume exposure EPZ an adequate opportunity to become aware of the information annually. The programs should include provision for written material that is likely to be available in a residence during an emergency. Updated information shall be disseminated at least annually. Signs or other measures shall also be used to disseminate to any transient population within the plume exposure pathway EPZ, appropriate information that would be helpful if an emergency or accident occurs. Such notices should refer the transient to the telephone directory or other source of local emergency information and guide the visitor to appropriate radio and television frequencies.*

  Information for the transient population is not included in the plan.

- *II.K.5 – Each organization, as appropriate, shall specify action levels for determining the need for decontamination. Shall also establish the means for radiological decontamination of emergency personnel wounds, supplies, instruments and equipment, and for waste disposal.*

  Decontamination is given only a brief mention in the plan, and the levels and means for determining decontamination are not discussed.

4.2.3 Fishers Island Plan Review

The Fishers Island plan provided to the reviewer appears to be essentially an operations plan, composed mainly of various checklists. It does not address planning and mitigation issues directly, and for this reason, it was found not to be non-compliant with many of the stated requirements. Interviews with responsible Fishers Island personnel reveal a level of readiness and understanding of radiological response not reflected in their formal planning documents.

This remains a potentially serious disconnect, since the lack of a detailed plan is generally an indication that much of the critical information could be lost with the turnover of key personnel.

To provide a fuller picture, the analysis of Fishers Island, which follows, is based in part on discussions with the personnel about their concepts of operations for radiological response. That discussion is followed by a listing of some of the more notable shortfalls of their written plan.

IEM focused our review of plan integration issues for the State of Connecticut and Fishers Island plans primarily in the areas of alert and notification, protective action decision-making, general communications connectivity during an emergency and the conduct of an evacuation of the population of Fishers Island. These areas were judged to be the most significant as related to possible planning or operational disconnects that could affect the safety of the New York 10-mile emergency planning zone population in the event of a Millstone accident. The evaluation of the alert and notification connectivity is detailed in Section 5.3 of this report. The protective action decision-making process used by the Millstone licensee and State of Connecticut is described in Section 3.5.2. Communications connectivity between Fishers Island and the State of Connecticut is summarized in Section 5.4. There were no significant public safety-related plan integration shortfalls identified for any of those areas.

Plan coordination between the State of Connecticut and Fishers Island in the event of an evacuation of the island has an appropriate level of breadth and depth. Responsible officials on Fishers Island appear comfortable with all aspects of the planning with the exception of the availability of ferries in an actual emergency. There is an issue with lack of specific training for ferry crews identified in Chapter 6 that potentially bears on this concern. Weather conditions that would threaten safe ferry operations would also make it less likely for a radiological plume to actually threaten the island. Generally, winds that would cause seas to be at high enough levels to preclude operation of the ferries would come from directions that would drive the plume away from rather than toward the island. The State of New York may have an interest in further discussions with the company that operates the ferries and facilitating some type of crew training, through the State of Connecticut or directly. IEM should also point out that backup waterborne transportation resources do exist in the form of Plum Island’s indigenous boat transportation. There are existing agreements between Plum Island, Fishers Island and the State of Connecticut that identify these assets as potential support for a Fishers Island evacuation.

The only other concern reviewers had with the integration of the island evacuation plan was the availability of transportation resources once people were delivered by ferry to Stonington or New London, Connecticut. The plan states that the people will be transported from the disembarkation point to the host community of Windham via assets tasked from the State of Connecticut transportation staging area located at Stonington. Plans do not detail that the ground transportation assets are dedicated to the Fishers Island population and what backup capacity exists in the staging area specific to that mission. It is assumed that the State's transportation staging area will support multiple requirements during a radiological emergency and that there will be competition for transportation resources. IEM was not able to verify the capacity of the staging area via observation in an actual exercise, which would have been the best alternative to assess this particular point. The State of New York may have an interest in a follow up discussion with the State of Connecticut on the issue of capacity and contingencies for the ground transport part of the Fishers Island evacuation.

The Fishers Island compliance review matrix is in Appendix C. Following is a discussion of some of the more significant compliance issues noted by the reviewer.

- *II.F.1 – The communication plans for emergencies shall include all organizational titles and alternates for both ends of the communication links. Each organization shall establish reliable primary and backup means of communication for licensees, local and State response organizations. Such systems should be selected to be compatible with one another. (See NUREG-0654 for detailed requirements)*

  Communication plans were not clearly stated. The plan did not mention organizational titles and alternates nor did it include a clear demonstration of a backup communications system.

- *II.F.2 – Each organization shall ensure that a coordinated communication link for fixed and mobile medical support facilities exists.*

  The plan provided contains no reference to coordinated communications relative to medical support.

- *II.G.2 – The public information program shall provide the permanent and transient adult population within the plume exposure EPZ an adequate opportunity to become aware of the information annually. The programs should include provision for written material that is likely to be available in a residence during an emergency. Updated information shall be disseminated at least annually. Signs or other measures shall also be used to disseminate to any transient population within the plume exposure pathway EPZ, appropriate information that would be helpful if an emergency or accident occurs. Such notices should refer the transient to the telephone directory or other source of local emergency information and guide the visitor to appropriate radio and television frequencies.*

  The plan provided to the reviewer contains no mention of disseminating information to the transient population.

- *II.H.10 – Each organization shall make provisions to inspect, inventory, and operationally check emergency equipment/instruments at least once each calendar quarter and after each use.*

  There is no discussion of equipment inspections, inventory, and operability in the plan provided to the reviewer.

- *II.H.12 – Each organization shall establish a central point (preferably associated with the licensee's near-site EOF), for the receipt and analysis of all field monitoring data* *and coordination of sample media*

The plan provided to the reviewer does not clearly identify the required information in regard to field data reporting and analysis. Clear specification of where the data is to be reported and to whom is critical to public safety, because it is a key part of determining protective actions.

- *II.J.12 – Each organization shall describe the means for registering and monitoring of evacuees at relocation centers in host areas. The personnel and equipment available should be capable of monitoring within about a 12 hour period all residents and transients in the plume exposure EPZ arriving at relocation centers.*

  The plan includes no discussion of the functions of a relocation center.

- *Evacuation (urgent removal of persons/animals) and Sheltering (supplemented by bathing and changing of clothes) to protect the public from exposure to direct radiation and inhalation from airborne plume*

  Protective actions for civilians are not addressed in the plan provided.

- *Relocation and decontamination for protection against whole body dose (external exposure) due to deposited material and from inhalation of any re-suspended radioactive particulate.*

  The process for relocation and decontamination protection is not mentioned in the plan provided to the reviewer.

- *Levels of exposure to radiation identified which should initiate protective action.*

  The plan identifies only the level of exposure for emergency workers; it does not include the levels of exposure for the public.

- *All Protective Action Guidelines should be consistent for all of the population.*

  Public protection is not discussed in the plan provided to the reviewer.

- *Estimate of total doses received prior to relocation of population.*

  Population relocation is not referred to in the plan provided to the reviewer.

4.2.4 Plum Island Plan Review

Plum Island is in the 10-mile emergency planning zone for Millstone. James Lee Witt Associates did an assessment of Plum Island preparedness despite the fact that the island and its facilities are under the direct control of the U.S. Department of Agriculture. As a federally owned and operated facility, Plum Island is not under the direct responsibility of the State of New York for radiological emergency preparedness or other emergency management considerations. However, Plum Island does have a New York-based worker population that will potentially interact with Suffolk County and its population in the event of a release from Millstone. Based on the fact that Plum Island radiological emergency preparedness is a federal responsibility, a plan compliance matrix was not completed for the Animal Disease Center. The preparedness review is based on the concept of operation and other information in the Plum Island radiological emergency preparedness plan dated September 1993, and interviews conducted by JLWA.

Plum Island Animal Disease Center is an 800-acre facility wholly under the jurisdiction of the Federal government. The centerpiece of their extensive facilities is a set of laboratories with negative pressure heating, ventilation, and air conditioning (HVAC) system, making them particularly unsuitable for shelter-in-place purposes. Plum Island is linked to the Connecticut Emergency Operations Center as well as New York and Connecticut communities by high- and low- band radios. The island has multiple warning reception capabilities, 3 voice sirens with 3 control points, and both a primary and alternate Emergency Operations Center. Internal notification on the island includes a call-down system and a fire alert system. Good relations and mutual support agreements with the town of Southold (on Long Island) are in place.

The Animal Disease Center has three boats that can be used for evacuation, with emergency capacities of approximately 400, 200, and 100 respectively. There are two planned ports of debarkation; located ten minutes and 45 minutes travel time from the Plum Island ferry landing. In an emergency, the disease center would evacuate up to 200+ non-essential personnel, leaving 6-12 for facility and animal maintenance. Critical personnel will be rotated as necessary for exposure control. Should it be necessary, the essential workers have the capability to remain in place for several days. The essential workers, and those who would relieve those workers, all have protective clothing, respiratory protection, and potassium iodide. Their emergency kits contain thermoluminescent dosimeters and two types of small detectors. The disease center also has CDV 700 series survey instruments. The State of Connecticut currently provides calibration assistance for the radiological monitoring equipment.

There are no dependent populations, children or others requiring special consideration on Plum Island. The disease center staff stores emergency worker kits and will get potassium iodide distributed through the State of Connecticut. Plum Island workers have not had family protection planning training. It is important to note that Plum Island can assist Fishers Island both with radiological monitoring capabilities and with evacuation using the disease center's small fleet of boats. Drills have been conducted for this pursuant to a mutual aid agreement with the Southold Fire Department.

Although the Plum Island Animal Disease Center plan is in need of revision, the facility's capabilities appear more than adequate to protect their employees and visitors. Their capabilities are properly considered as available for potential augmentation of Southold's emergency response capabilities, including help in evacuating Fishers Island.

There were no significant issues noted with the integration of Plum Island radiological emergency preparedness planning with the Millstone jurisdictions. From the Plum Island side, the radiological emergency preparedness plan addresses integrated planning, specifically for an evacuation to Orient Point or to an alternate location on Long Island. However, the Suffolk County emergency plan provided for review covered hurricanes and severe storms and only mentioned notification of Plum Island for instances of severe weather. Since there was no content specific to radiological emergency preparedness in the Suffolk County plan—especially on the issue of disembarking Plum Island employees in an evacuation—it is not clear how deeply plan integration has been addressed by Suffolk County emergency managers. This is not judged to be a significant public safety issue since the addition of 200+ people arriving generally at a location where they will have access to their personal vehicles will not put much additional stress on county roads or resources. If the alternate point of debarkation is used in a Plum Island evacuation it would present a larger coordination issue. It is not clear if this type planning coordination has been accomplished. .

A final observation reviewers noted is that neither Plum Island nor the other areas of New York within the 10-mile emergency planning zone are included in the New York State radiological emergency preparedness plan.

4.2.5 Suffolk County Plan Review

As discussed in the preceding section, the Suffolk County plan provided for review is focused on hurricanes and coastal emergencies. It contains no mention of radiological planning, so reviewers were unable to complete a radiological emergency preparedness compliance matrix for it.

The majority of Suffolk County lies to the Southwest of the above two islands and is outside of the ten-mile emergency planning zone. The east end of the County is closest to the plant. Summer and weekend populations are significantly higher than the level of permanent residents. The area has few arterials and is not well suited to moving large numbers of vehicles in a short period. There is not a well developed network of backroads that can be used and some areas might have half a million people who, should they need or choose to leave, would need to cross over two small bridges or leave by boat. Such an evacuation from east to west, whether planned or spontaneous, would run into communities further west that are similarly constricted in their evacuation options. It is anticipated that the difficulties with such evacuation does not lie primarily in the potential exposure of people to harmful dose levels, given Suffolk County's distance from Millstone; rather, it represents a potential load on resources and transportation infrastructure.

The Suffolk County Emergency Operations Center is capacious and relatively modern. The staff seemed capable, but no operations were observed. Police forces are small and fire response capabilities require volunteers. Although they have evacuation experience, it is primarily with hurricanes. Hurricanes differ from radiological events by being more frequent and (for many people) less threatening.   Also, hurricanes become evident long before the threat arrives, and require partial evacuation (primarily from low lying coastal areas) rather than general evacuation.

The public safety implications of spontaneous evacuation are of major concern. Also of major concern in the communities visited is the inability of those outside the 10-mile emergency planning zone to get timely and accurate information on the status of the plant and the likelihood of contamination of portions of the County. These concerns differ from those found among communities around Indian Point only in degree, for reasons discussed above. We believe the concerns are legitimate, because the public safety implications of spontaneous evacuation can be mitigated with planning and preparedness efforts that recognize the reality of the phenomenon, and because accurate and timely information is essential for the credibility of local authorities and the ability of local response organizations to get ahead of an unplanned public response and dampen the phenomenon (if appropriate) and mitigate its effects.

4.3 Conclusions from Individual Plan Reviews

A review of the matrices shows that all of the organizations fail to meet some of the regulatory criteria. Certainly, every area in which each of the plans failed to meet a regulatory requirement should be followed up to bring the plan into compliance, since some of the issues noted above represent potentially serious concerns.

With respect to the plans for the organizations concerned with a response at Indian Point, it is difficult to draw a series of strong conclusions about trends in the level of preparedness of the various response organizations based on the individual plan compliance review. As discussed in the introduction to this section, many of these failed requirements can very likely be brought into compliance relatively easily--through better and more complete integration of already existing response information into the plan document. That is, there is a relatively high level of confidence among the reviewers that much of the required planning information exists within the emergency response organizations; it just is not in the specified locations or formats within the plans.

Reviewers noted one possible exception to this judgment on general availability of information for the Indian Point jurisdictions. This possible omission is specific to protection of the water supply. Although plans generally addressed protection of food and water as required by applicable guidance in the EPA 400 and applicable Food and Drug Administration documents, there was no mention of the site-specific sensitivity of the New York reservoir system to a radiological release. This is a significant observation given the large New York population potentially served by these water supplies. It is not clear whether any detailed planning has been accomplished as to protection or priority sampling of the reservoirs in the event of a radiological accident, or who at the State would be primarily responsible for coordination of such activities. If such planning has been done and responsibility has been defined, the New York State REP plan should at a minimum summarize this and cross reference any documentation that delineates operational procedures of the responsible agency. If this documentation does not exist, then responsibilities should be defined by the State and supporting documentation developed as a priority.

The reviewers do not have as a high a level of confidence about the existence of such information in the plans for the New York jurisdictions associated with Millstone. While Fishers Island seems to be fairly well in compliance in terms of practice, the lack of detailed documentation is a pervasive weakness. The response knowledge currently within the organization could be easily lost with the departure of a few key personnel.

Also, as previously stated, the omission from the New York State plan of both populations within the Millstone 10-mile emergency planning zone is of concern, and reflects at the State level the lack of rigorous planning documentation found at the local level. This omission is problematic, given that people will react to an event at Millstone in ways that have public safety implications beyond the 10-mile emergency planning zone in New York.

The strongest concerns lie with the lack of any documented radiological planning for Suffolk County, including with respect to the intersection of the County with necessary planning for Plum Island evacuation, as discussed previously.

4.4 Performance Analysis of Radiological Emergency Plans

Radiological plans are expected to accomplish a purpose, as laid out in NUREG-0654, Rev. 1:

> The overall objective of emergency response plans is to provide **dose saving** (and in some cases **immediate life savings**) for a spectrum of accidents that could produce off-site doses in excess of Protective Action Guides. (emphasis added).

Emergency plans need to address how to accomplish dose saving during the early phase of an accident. This phase, lasting from hours to days, is when effective protective actions must be put into place to reduce people's exposure to radiation.

There are federal guidelines for how much dose saving is desired. These guidelines are meant to provide guidance for response decisions and are not dose limits.[32] Chapter 3 mentioned the protective action guidelines established by the Environmental Protection Agency for acute radiation effects from nuclear accidents. Federal guidance suggests that there are four protective actions that can be taken separately or in combination to protect against direct exposure:[33]

- Evacuation
- Sheltering
- Administration of stable iodine
- Washing exposed skin surfaces and changing clothes

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[32] Environmental Protection Agency. *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*. EPA-400-R-92-001.
[33] A fifth measure—food, water, milk, and livestock feed control—is implemented in the 50-mile ingestion emergency planning zone to prevent accumulation of a hazardous dose over a more extended period

Evacuation is recommended when exposure to the public is expected to exceed 1 rem.[34] An analysis completed by the Environmental Protection Agency indicated that the risk avoided is usually larger than the risk incurred by evacuating when exposure to the public is larger than 1 rem.[35] The guidelines acknowledge that, under some circumstances, individuals may be exposed to up to 5 rem.

Sheltering in structures is another protective action. The Environmental Protection Agency does not recommend sheltering if the expected dose exceeds 10 rem.[36] The outside air slowly penetrates the inside of a structure, so sheltering is not recommended for some types of accidents. Sheltering in some structures is more effective than others:[37]

- Wood-frame house (first floor): 10% reduction in dose
- Wood-frame house (basement): 40% reduction in dose
- Masonry house: 40% reduction in dose
- Office or industrial building: 80% or better reduction in dose

The protection afforded by sheltering is greater when people close all doors and windows, shut off ventilation systems (these draw in outside air), and seal minor openings using towels, tape/plastic, etc. The Rockland, Westchester, and Putnam County plans provide information on how to shelter effectively. The Orange County plan includes some information for school populations in the Alert phase based on projected dose estimates. This is described as a *selective sheltering* procedure**.**

Stable iodine (also referred to as Potassium Iodine) represents another line of defense. Inhaled radioiodine concentrates in the thyroid in the human body. The total amount of inhaled dose may be 5 to 50 times larger in the thyroid.[38] For accidents that involve radioiodine releases, people can take stable iodine to lower the dose received. Stable iodine is most effective when it is taken prior to exposure; however, taking stable iodine can be very effective if ingested within one or two hours after exposure. The Environmental Protection Agency recommends that stable iodine use should be considered if the thyroid dose is expected to be 25 rem or higher.

Washing exposed skin surfaces and changing clothes as soon as practicable after a release ends or exposure ceases can reduce some exposure from the particulate materials and beta radiation from radioiodines that can deposit on the skin. The Environmental Protection Agency recommends washing and changing clothes as a protective measure for even alpha-emitting releases as soon as practical. All four county radiological emergency preparedness plans have separate sections on decontamination procedures and exposure control. The sections discuss in detail the decontamination procedure with respect to the general public and emergency workers.

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[34] A rem is roentgen equivalent man—a measure of radiological exposure. The probability of a person having "health detriment" due to receiving one rem of radiation is estimated to be 7×10^{-4} (about once in 1400 years). This probability was derived from recommended values by the National Council on Radiation Protection (NCRP) and International Commission on Radiation Protection (ICRP).
[35] Environmental Protection Agency 400-R-92-001, page 4-5
[36] Environmental Protection Agency 400-R-92-001, page 4-5
[37] Environmental Protection Agency 400-R-92-001, page 4-5
[38] Environmental Protection Agency 400-R-92-001.

The process includes washing, use of soap, change of clothes, and also control of the drainage water.

Emergency plans for the region identify the need to make decisions to reduce exposures. They also identify the roles and responsibilities of agencies that need to decide on the protective actions to be employed. However, there is no analysis of strategies to protect people during response, nor is there a pre-identification of which protective actions would accomplish the best dose savings under different accident release circumstances.

A comprehensive analysis was completed as a part of the development of the EPA-400 guidance document to explore the recommended levels of exposure at which various protective actions should be taken and the costs of taking such actions. This analysis established the technical base for recommended levels of protection and the means to accomplish them (evacuation, sheltering, administration of stable iodine, and washing and changing clothes).

There is no indication that similar analysis was conducted for the Indian Point region. Technical analyses underlying federal guidelines are, by nature, general and do not account for local variations. These wide-ranging variations include the following: the type of accidents possible at a specific plant; the weather at a specific site; the distribution of populations around the site; the unique nature of the populations around the site (numbers of infirm, children, elderly, special groups with marked variations in eating habits); specific road networks and traffic congestion patterns; specific arrays of buildings with varying degrees of air-tightness; the sum of the resources available in the region for response actions (including individual, private and public resources); and the expected willingness and ability of the local populace to understand and take the actions necessary for their own protection. The right strategies are the ones that can combine this complex set of variables and define the best means of protection under a variety of circumstances. This analysis can be distilled into **actionable guides** that can be quickly and easily used during response.

Plans should guide effective action in response. Planning is not an end unto itself. It is useful if it improves operations or the actual management of disasters. Facility, county, and State emergency managers need to provide protective action decisions to the people in the area. These recommended actions need to be based on the best possible examination of the expected hazards and the best means to provide protection. Identification of effective protective action strategies requires considering not just **who** is at risk and **where**, but also **when.** As NUREG-0654 states:

> Information on the time frames of accidents is also important. The time between the initial recognition at a nuclear facility that a serious accident is in progress and the beginning of the radioactive release to the surrounding environment is critical in determining the type of protective actions which are feasible. Knowledge of the potential duration of release and the time available before exposures are expected several miles off-site is important in determining what specific instructions can be given to the public.[39]

[39] NUREG-0654, Rev.1, pages 7-8.

This decision-making is complex. Each of the emergency zones must be separately considered—the best protective action for many zones under a specific accident condition may be different from the best action for other zones. All this must be done quickly during response to an event.

There is an effective time window for action in each emergency, where many actions are possible. As time passes, the range of options may narrow and the effectiveness of the action may diminish:

> Decisions during nuclear emergencies can be expected to be highly stressful. Time will be short, information imperfect, and tradeoffs inevitable. And, of course, many lives will be at stake.[40]

Calculations of the optimal strategies for protecting the public safety and health are best done during the planning phase and incorporated into the emergency plans. There are no such comprehensive analyses incorporated as a part of the plans for the Indian Point facility, counties, or the State of New York.

There are historical reference points that show that this problem was recognized as far back as the review of planning around the Three Mile Island site.

> ...[U]nder conditions of stress, it is unlikely that the TMI emergency director could receive all relevant information from plant operators, transpose it into usable information for public organizations, and transmit it to them in a timely manner. Yet, inspection of the TMI plan reveals no other operating procedure for this process to occur.[41]

The same review also mentioned a problem with the form and content of the plans:

> Plans generally list responsibilities but make no attempt to anticipate problems that would prevent emergency management objectives from being reached. Nor do plans specify how such problems would be solved….The way planning documents are written, it is virtually impossible to determine, except through hindsight, if operational objectives would be met.[42]

Plans in general are not operational guides. They only assign responsibilities. Thus, they focus on the **who** and not the **what** and the **how**.[43]

To develop a public protective action strategy plan, decisions need to be made with respect to several variables that affect the capability to evacuate and implement in-place sheltering. These complex functions cannot be performed in the limited time, stressful conditions, and uncertainties of a response. An associated federal program, the Chemical Stockpile Emergency

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[40] Kasperson, Roger E., Dominic Golding, and Seth Tuler. "Designing Effective Decision Systems for Responding to Nuclear Plant Emergencies." In *Preparing for Nuclear Power Plan Accidents* (edited by Dominic Golding, Jeanne Kasperson, and Roger Kasperson), Westview Press. 1990. Page 306.
[41] Dynes, Russell, Arthur Purcell, Dennis Wenger, Philip Stern, Robert Stallings and Quinten Johnson. *The Accident at Three Mile Island: Report of the Emergency Preparedness and Response Task Force*. Disaster Research Center, University of Delaware. 1990.
[42] Dynes, Purcell, et al.
[43] If plans cover everything that needs to be done, they fall into the other trap of disaster planning: plans that are so detailed that they have to script every turn of events. It highly unlikely that any actual emergency will follow such scripts.

Preparedness Program (CSEPP),[44] has developed a more sophisticated approach for handling this problem.

The *Planning Guidance* for the Chemical Stockpile Emergency Preparedness Program recommends that "a two-part process" be used in the development of protective action strategies. As the *Planning Guidance* states, the first step is to decide on the set of protective actions to be used under different emergency conditions:

> When determining which action provides adequate protection for a given area or population group, one should consider:
>
> - The protective capacity of the action (i.e., its ability to provide protection once implemented);
> - The likelihood of the action being implemented by people in the risk area;
> - The time required to implement the action versus the time available before the toxic plume arrives;
> - The social and psychological effects of planning and implementing the action;
> - The risk to the public when implementing the action.
>
> This information should be a part of the Protective Action Strategy Plan in the Emergency Operations Plan.
>
> The second step, to be performed at the time of the emergency situation, consists simply of determining what conditions exist in that situation and, thus, which of the pre-determined actions should be implemented.[45]

Emergency managers need to have a planning process that allows them to take appropriate actions during response. The appropriate action may not be the fastest action. It certainly will not be a completely pre-scripted action. The particulars of the situation need to be assessed during operations to determine what the course of action should be. However, the urgency of most decision making during disasters generally requires prompt action. Planning is expected to help define appropriate actions that can be implemented operationally.

Evacuation may not be feasible under all types of radiological accidents at Indian Point or Millstone. Sheltering may afford better protection under some conditions. In fact, our experience in analyzing protective actions at chemical weapon sites indicate that a "balanced" strategy of considering all protective actions (particularly evacuation and sheltering) provides the best protection for the public. This point became apparent in one FEMA-directed study of communities located in the vicinity of a government chemical weapons storage facility:

> …[P]reliminary evacuation studies [indicated] that an "evacuate first" approach does not protect people adequately in the Alabama CSEPP footprint. Initial evacuation time estimates were very long due to interaction between zones, especially in large-scale evacuations. Sheltering as the sole protective action also revealed several zones not protected adequately…[46]

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[44] The Chemical Stockpile Emergency Preparedness Program defines guidelines for protection around chemical weapon stockpile sites in the United States.

[45] FEMA/Department of the Army, Planning Guidance for the Chemical Stockpile Emergency Preparedness Program, May 17, 1996.

[46] Wilson, Krause. *Technical Addendum to Alabama CSEPP Protective Action Recommendation Guidebook*. Innovative Emergency Management IEM/TEC00-023, February 2000. Page i.

This kind of situation requires a simultaneous evaluation of whether to evacuate or shelter, not a sequential one. Currently, federal guidelines recommend evacuating if possible and sheltering as the alternative. This decision approach has not been sufficiently protective for chemical weapon emergencies and may not be sufficiently protective for nuclear emergencies.

One of the most successful evacuations was in 1979 at Mississauga, Ontario, Canada. A train carrying chemicals derailed and caught fire. A total of 217,000 people were evacuated during this protracted event. After the emergency was over, the emergency organizations in Mississauga received numerous requests from other jurisdictions asking for a copy of their emergency plan. Analyses of these and other emergencies noted the following:

> Yet the secret of behind the unprecedented success of this large-scale operation [Mississauga evacuation] did not lie in the document. Everything hinged on the life breathed into these plans (which were fairly conventional): a general policy of observing risks and vulnerability, frequent exercises, careful analyses of experience, effective involvement of people at the top of the hierarchy, and a joint effort carried out by many partners. For years, everyone involved had been preoccupied with translating the keywords—trust and competence—into something real.[47]
>
> The key [to good planning] lies in building a continuously-oiled system whose capacity for changing speeds is tested regularly. A plan should be the picture on paper of a real capacity for action and interaction among numerous actors—from industry leaders and public authorities down to individual citizens, via various groups and associations."[48]
>
> The concept of emergency planning zones necessarily implies mutually supportive emergency planning and preparedness arrangements by several layers of government: Federal, State and local governments, including counties, townships and even villages.[49]
>
> Implementing the protective actions successfully over several counties, tens of localities, hundreds of emergency organizations and institutions, thousands of emergency workers, and tens of thousands of the public will require very careful planning, an effective communication system, and strong **inter-organizational coordination**. This is not to say that a successful evacuation cannot be achieved, only that the task is formidable (emphasis added).[50]

JLWA/IEM reviewed the evacuation procedure of the counties around Indian Point in detail. Evaluation of the county plans indicated that each county recognized that evacuation demands a coordinated effort between the plant, county agencies and the State. The Rockland plan specifically identifies the fact that an evacuation order should be coordinated with the Executives of the other three counties (Westchester, Putnam and Orange) surrounding the Indian Point facility, and the Chairman of New York State Disaster Preparedness Commission at the New York State Emergency Operations Center.

Study of the designated evacuation routes from the individual County Public Information Brochures[51] for each of the four counties illustrates the importance of a coordinated protective

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[47] Ladadec, Patrick. *States of Emergency: Technological Failures and Social Destabilization*. Butterworth-Heinemann. 1990. Page 242.
[48] Ladadec, page 242.
[49] NUREG-0654, Revision 1.
[50] Kasperson, et al. 1995. 301.
[51] *Emergency Information*, Orange County Emergency Management Office, County Government Center; *Emergency Information*, Westchester County Department of Emergency Services, Office of Emergency Management; *Emergency Information*, Putnam County Bureau of Emergency Services; *Emergency Information*, Rockland County Office of Fire and Emergency Services. All Revisions Year 2001.

action decision by the counties, especially in an 'evacuation scenario.' The four counties considered here do not evacuate as independent entities. In other words, the counties actually share evacuation routes across county borders and evacuees have been directed to cross county lines and move into adjacent counties during an evacuation. This means evacuees from Westchester County can travel northwards and evacuate through Putnam County. A similar strategy holds for evacuees in Rockland and Orange Counties. Such a 'fluid' evacuation strategy within the counties demands a lot of coordination and thorough understanding of the multi-jurisdictional issues.

None of the plans provided any Memorandums of Understanding (MOU) between the disparate agencies who would be involved in a multi-jurisdictional evacuation. While we witnessed good cooperation during the exercise, there are benefits to the development and the possession of up to date MOUs.

None of the four county radiological emergency plans "**met**" the 'Evaluation Criteria' drawn from NUREG-0654, II.J.2, which states:

> Each Licensee shall make provisions for evacuation routes and transportation for on-site individuals to some suitable off-site location, including alternatives for inclement weather, high traffic density and specific radiological conditions.

NUREG- 0654 also requires the protective action criteria to be evaluated for '*Applicability and Cross Reference to Plans*' at the licensee, State and local levels.

All four county plans contain a detailed section on evacuation as a part of their protective action responses; however, they are tuned towards general evacuation and do not include specific consideration of Indian Point personnel. The NUREG criterion has been regarded as 'not applicable' in the "NUREG-0654 Cross Reference and Procedure Cross Reference" section in the Orange and Putnam County plans, presumably because of the location of the plant. In all four county plans on-site evacuation has been treated as equivalent to 'general evacuation' and not treated separately. Whether or not this assumption would have a potential public safety impact depends on the impact of the on-site population upon evacuation time estimates for the general population. It is not clear in the material reviewed whether or not the counties identified this as an issue or attempted to analyze it.

4.5 Related Planning and Preparedness Reviews

As part of the overall emergency plan review effort, James Lee Witt Associates considered the preparedness of special facilities. Because of the vast number of these facilities, we selected a sample and used personal interviews focusing on preparedness issues both general and specific to the type of facility. Our goal was to gain insight into significant segments of the preparedness picture that would not otherwise be obtained. Our goal was not to conduct a survey of opinions and expected behaviors of the kind we recommend elsewhere in this report. In this regard, we recognize the limitations inherent in using personal views, even when those views relate solely to the area of professional expertise of the person interviewed. We know too that what people say they would do in an event is not necessarily what they will do in a real event. People often rise to the occasion. Nevertheless, it is legitimate to attach importance to views that are repeated by a number of individuals, in a variety of occupations and differing circumstances. It is legitimate to give weight to attitudes and beliefs when our prior emergency management and disaster experience indicates those attitudes and beliefs may become important to effective response to a real event. Had we not ourselves interviewed within the communities, or not used the information received because of its inherently subjective nature, we would have a less complete view of the preparedness of the region and of the effectiveness of the plans.

This specific outreach effort was not duplicated for Millstone area, because of the dearth of facilities in the plume EPZ. Some of the observations have obvious implications for planning in Suffolk County however.

Our methodology is outlined in Appendix A. Most of the recommendations for improvement that surfaced from these interviews can be found in the appropriate sections of this report. It can be noted here however that after reviewing the technology available for use by supporting institutions, the IEM/JLWA team recommends that GPS capability be added for police, fire services, and emergency medical services so that evacuation route information is accessible for emergency responders. The following sections summarize the results of our outreach effort for medical services, law enforcement, fire services, public works, transportation, schools and West Point Military Academy.

4.5.1 Medical Preparedness

Overall medical preparedness of a region is a major and complex issue that considers how all of the various divisions of the relevant hospitals and emergency medical service providers interact under changing conditions, and properly requires a dedicated study in itself. Many health facility officials were interviewed in the course of our outreach effort, including Helen Hayes Hospital, Hudson Valley Hospital, Nyack Manor, Hillcrest Nursing Home, and Assisted Living at Northern Riverview, but a major study was not conducted. Nevertheless, to get a better feel for the state of medical preparedness in the area, JLWA/IEM conducted a more detailed evaluation of preparedness at Good Samaritan Hospital, located in Rockland County approximately 15 miles from Indian Point.[52]

Staff at Good Samaritan Hospital is clearly dedicated to improving their preparedness and were serious and effective participants in our review. While areas for improvement that may be more generally applicable were identified, readers are reminded that our evaluation represents a limited snapshot of one hospital in one county. It should not be construed as representative of medical preparedness overall for the Indian Point emergency planning zone.

[52] There are two other hospitals located within Rockland County: Helen Hayes Hospital, a 155 bed Rehabilitation Hospital; and Nyack Hospital, a teaching hospital affiliated with Columbia University Medical School (P&S).

4.5.1.1 Review of Written Plans

We reviewed the following plans, which were provided to us by the hospital:

Plan Name	Date Developed	Date of Last Review
Power Failure	2/92	not available
Decontamination Policy/Procedure	4/92	12/2000
Evacuation Plan	10/95	12/2000
Outcome, Policy Statement (number 2307)	10/95	12/2000
Fire Drills	10/95	9/2000
Outcome, Policy Statement (number 2350)	5/97	not available

In their current state, the plans represent the Joint Commission Accrediting Hospital Organization (JCAHO) format, which was in place prior to 2000. The Environment of Care (EC) 1.4 section of the JCAHO standards contains the present standard and the components, which should be reflected in the hospital's plan.

Overall, the written plans are event-based for specific conditions, such as severe weather, mass casualty, power failure, loss of water, fire drills, and evacuation of the facility. The hospital has a separate plan for decontamination and treatment of radiological casualties, and frequently references Radiological Management Consultants (RMC) as the resource to be contacted in the event of a radiological event. There is extensive detail on decontamination procedures, setting up the hot/warm zone, personal protective equipment for staff, measuring levels of contamination, etc.

JLWA/IEM reviewers noted a number of potential opportunities for growth and enhancement of the written plans:

- Future iterations of the emergency plans should be consistent with JCAHO E.C. 1.4, and should ideally follow an all-hazards approach. An all-hazards approach provides a general approach to an emergency situation, with specific annexes for unique response situations, such as a chemical, biological or radiological event. In addition, a hazard vulnerability analysis should be performed, to be integrated with that which has been done by Rockland County Emergency Management. (Hospital staff stated that these requirements had already been identified and that a plan revision was in progress.)
- The plans contain no mention of a Hospital Emergency Incident Command System (HEICS) to be activated that is consistent with its counterpart in the larger community response. Such an incident command system is required both by JCAHO and by the Occupational Safety and Health Administration (OSHA) if decontamination of any type is performed. Staff members are directed to assemble at the desk in the Emergency Department once the plan is activated; however, there is no mention of an Emergency Operations Center or "Command Center" in the present structure, which would be separate from the Emergency Department.

- The use of personal protective equipment as part of decontamination operations requires the development of a written program addressing respirator and personal protective equipment guidance. This measure helps to assure the safety of staff members while in protective equipment, and limits the hospital's liability while personnel are in such clothing.
- The decontamination procedures described in the plan contain significant differences compared to the standards developed by the Oak Ridge National Laboratory (ORNL) Radiation Emergency Assistance Training Center (REACT/S) (rev. 4/2002). The Good Samaritan plan discusses use of RMC consultants in determining which patients would need specialized treatment, and names Northwestern Memorial Hospital in Chicago, IL, as the preferred treatment facility. Locating a closer facility with similar expertise, if one exists, may be advisable.
- The plan lists extended care facilities (ECF) and the number of patients each facility would be able to accommodate in the event patient transfer is contemplated. It was unclear if this data in the plan was current and if Memorandums of Understanding were in place with each facility.
- The evacuation plans contained in the document reviewed are general in nature. An assessment of the specific types of patients in the hospital, and their ability to evacuate should be considered for inclusion in the plan.
- Information on the flexibility of the heating, ventilation, air conditioning (HVAC) system and its ability to shut down air handlers as needed would be important to integrate into future plan revisions. This information most likely exists in the hospital's facility/engineering plan. Also, the emergency plan contains no mention of negative- or positive-pressure rooms or their locations–a resource which would be valuable for emergency planners and hospital responders.

4.5.1.2 Review of Hospital Staff Questionnaire and Interview Responses

We also reviewed Good Samaritan Hospital’s response to a questionnaire we provided to hospital personnel. Once questionnaire responses were received, James Lee Witt Associates interviewed hospital personnel to discuss the responses. In this process, certain areas of concern emerged related to the communication of event information to the hospital, dissemination of event information within the hospital, identification of specific staff responsibilities, and the need for associated training. These include the following:

- The hospital should incorporate into the command center phone lists and into revised plans a means of contacting the following: Rockland County Emergency Operations Center (Department of Health representative), the New York State Emergency Operations Center (Department of Health representative), the Indian Point Emergency Operations Facility, and the Joint News Center for Indian Point response.
- If provisions have not been made to back up communications with the agencies named above via emergency radio and commercial telephone, some method(s) of doing this should be considered. Options include using e-mail, amateur radio (ARES/RACES), cell phones, and beepers.

- The plan should clearly indicate who will officially provide the hospital with initial notification of a radiological event at Indian Point, to ensure that hospital personnel are receiving timely, valid, and accurate information. This protocol should be developed in concert with Rockland County emergency management officials and should be clearly documented in the plan.
- Assuming that initial notification of an event will be received in the Good Samaritan Hospital Emergency Department, the hospital should ensure that (1) Emergency Department personnel are aware that they will be the first point of contact for notification; (2) Personnel have been trained regarding what information might be provided in the notification, so that the receiver can accurately record the pertinent information for transmittal to the person(s) responsible for coordinating hospital response; and (3) Personnel who might receive the notification have been trained to recognize and request the information needed by the hospital to gauge the required response.
- After initial notification, there should be a clear understanding concerning what critical information should be updated periodically to allow the hospital to stay abreast of the situation, including the source and format of the updates. Also, there should be a clear understanding concerning what information the hospital should provide to others as the event progresses, including the intended recipient(s) and the means of transmitting this information.
- Periodic emergency communications checks of all communications means should be performed with county, state, and plant emergency management organizations (as applicable) to ensure that the systems are in working order and that phone lists are up-to-date.

We recommend that Good Samaritan Hospital exercise the radiological preparedness aspect of its emergency management plan more frequently than every two years, in order to maintain a high level of proficiency in specific skills needed to execute this aspect of the plan. Indian Point regularly conducts drills to meet training requirements for their emergency response organization. Each of these drills represents an opportunity to practice some aspect of radiological response at Good Samaritan Hospital in coordination with Indian Point's emergency response organization. Involving Rockland County emergency management staff in such drills might further help to identify and resolve additional integration issues.

As Good Samaritan Hospital is not within the ten-mile EPZ they do not have evacuation and sheltering plans for a radiological event. Our review of other health care institutions within that zone revealed a sensitivity and capability regarding these issues, with the concern most frequently expressed being the availability of ambulances and other suitable evacuation vehicles. Other concerns expressed mirror much of what is found above, with the condition of the roads, the lack of staff training, lack of significant involvement in exercises, and the possibility of losing staff being most often mentioned.

4.5.2 Law Enforcement

To sample the role of law enforcement facilities and their degree of safety, interviews were conducted with officials from Sing Sing, Westchester Department of Corrections, Highlands

Police Department, Stony Point Police Department, and the Rockland Police Chiefs Association. Additional insights were obtained from discussions with individual officers and elected officials.

4.5.2.1 Sing Sing

Sing Sing is a state maximum and medium security prison located in Westchester County, within the 10-mile emergency planning zone. They would receive warning from the Corrections component of the state response effort. Communications capabilities include radio and satellite. They have extensive shelter-in-place capability and consider themselves to be an asset to the community. For example they can produce 100,000 meals within 24 hours and provide shelter for members of the surrounding community. Several hundred people were assisted with food and shelter in a recent ice storm. They also can assist in traffic control and community security because the facility would be in lock-down.

Potassium iodide is located on-site, including dosages for visitors. They have no radiation monitors. They are confident that staff would remain on duty and off duty staff would report as required, provided roads are passable. There has been no hazard specific training for the staff, nor has there been training about family protection plans.

Should the State Emergency Management Office decide that evacuation is preferable to shelter-in-place, they would search for vacant cells by computer and evacuate accordingly. Inmates with psychological problems would be sent to a facility with appropriate capabilities. They plan for a two-tier process of evacuation using 36 secure coaches, 18 secure vans, and 10-non-secure vans. Additional resources are available from the state, and 170 secure coaches are available through arrangements with New Jersey. The State Police have the responsibility to escort them to their destination. The decision to evacuate would be based on health considerations and whether it is riskier to move inmates than to stay in place.

4.5.2.2 Westchester County Department of Corrections

The Westchester Department of Corrections facility is located outside of the ten-mile EPZ. It is smaller than Sing Sing, and has less extensive capabilities. They would learn of an event from the County EOC, and the County would decide appropriate protective actions. Communications cannot be considered adequate because they are non-secure, their frequencies are shared with neighboring businesses and they have no satellite communications.

They can shelter-in-place for one week, after which they would need both food supplies and fuel. They can also provide some sheltering for community members, up to about 500. Should relocation be desirable, the State Patrol is expected to assist, as with Sing Sing. The destination(s) was undetermined at the time of interview. “A few hours” would be necessary to vacate the facility.

There has been no hazard specific training for the staff, nor has there been training about family protection plans. Should there be an incident and a resultant lock down, the staff cannot leave, so they can be counted on to remain and perform their duties. The interviews did not elicit confidence that off duty personnel would report for duty in the case of a significant event.

4.5.2.3 Stony Point Police

They would receive notification from the County. Communications cannot be considered adequate because they share the county radio frequency with others and have no backup systems. Repeaters would be an improvement in their communications system.

They were troubled that while the County's plan looks good, the public will not cooperate and their expected behavior will frustrate the best of planning. 9/11 demonstrated that the assumptions made in the plan about public behavior are erroneous. For example, parents will go to the schools and thereby prevent orderly evacuation. A public information campaign will not solve this problem, and they do not intend to try to block this expected behavior. Even without that problem, the plan is faulty because by the time they mobilize the buses the roads will be gridlocked.

The roads are inadequate even without spontaneous evacuation. They have received little training and their officers are not familiar with the planned evacuation routes. They do not have a copy of the County plan, nor do they have a hazard specific plan outlining their responsibilities.

They had no notification during the February 2001 Alert, which shook everyone's confidence in the plan. This, plus the prevailing skepticism toward government plans, makes public education an uphill battle.

Those officers on shift or who reside locally are expected to perform their duties. Recalling the force from outside the area may result in a 75% response.

Exercises are thought not to reflect on the practicality of the plan because they are always simulated or table top.

On the positive side, they do not have the complicating problems of homelessness, jails, and transportation-dependent group homes, nor do they expect civil unrest or looting. They do have personnel certified for HAZMAT response. All seven sedans have laptops, so if they had GPS software, as noted above, they could have evacuation routes available on these laptops.

4.5.2.4 Highlands Police Department

Highlands receives notice from the County, through the Town Clerk. Because of the mountains and the few narrow roads the community is isolated in severe weather, and an accident can backup the evacuation routes for hours. There are no county facilities located in or near the Town, resulting in their unavailability in case of immediate need. Reversing traffic is thought to be impractical and dangerous. They have not been allowed to participate in table top exercises.

Although they have low band, hi-band and 800 megahertz radios, their communications is inadequate. The 911 center must call Highlands to verbally relay requests for information. The two repeater sites are inadequate and the mobile 30 watt radios do not work reliably in the mountainous terrain. Three additional repeaters are thought to be necessary. The fire department is reported to have similar problems. The County Emergency Operations Center sometimes does not answer calls.

Opinions about the practicality of the evacuation plan, the consequences of spontaneous evacuation, the behavior of parents and citizens, and skepticism among first responders, are similar in content to those found in Stony Point. We also were advised that there are concerns with the evacuation plan as it relates to busing because the buses are located on the other side of the mountain and the roads may become impassable.

4.5.2.5 Rockland County Police Chiefs Association

We discussed the County's plan with the Rockland Police Chiefs Association. While we recognize that group dynamics may prevent dissenting opinions from surfacing there was, nevertheless, convincing general skepticism regarding the practicality of the plan. The skepticism flowed from observations about parental behavior, knowledge of road conditions, experience with smaller scale evacuation events such as for Palisades Mall, the availability of sufficient buses, the lack of adequate officer training and the expectation of widespread counterproductive behavior due to fear. There was disagreement on the willingness of officers to report for duty and the adequacy of personal protective equipment. There was agreement that without public cooperation, the County's plan will not work, and that recent drills do not give a good idea of the level of preparedness of those tested. As one would expect, this group also was concerned about the unique aspects of a terrorist attack, such as the probability that other related targets, like bridges, would be attacked at the same time, complicating response and effective evacuation.

4.5.3 Fire Services

Discussions with Fire Chiefs in three counties, many of whom are volunteers, indicated a low level of knowledge of the role of the fire services in the event of an incident at Indian Point. Few appeared to know of their role in augmenting law enforcement, and when they heard of it, thought they would be ignored by the motoring public. Further, they expressed pessimism that their volunteer firefighters would perform their roles instead of taking care of their families first. That volunteer firefighters had neither the training nor the equipment to properly perform their roles was often voiced, though there was much disagreement on this point. Training in decontamination, the nature of the hazard and family protection planning was instanced during the discussions as specifically missing.

There was more support for reversing road lanes than was found among law enforcement and public works personnel. They agreed with law enforcement on the inadequacies of current communications systems, the irrelevance of major exercises as an indicator of preparedness, and the improbability of successful evacuation, especially in inclement weather. They also agreed with the frequently expressed view that sirens are a mixed blessing: their use (as in testing) results in people calling 911 to see what is going on. A radiological event hotline might help here. Some expressed worries, also voiced in public hearings, about containing water used in decontamination.

4.5.4 United States Military Academy at West Point

Located within Orange County and the 10-mile emergency planning zone, the United States Military Academy at West Point has historically been uninvolved in the planning and exercising for a release from Indian Point. That is now being changed. Earlier there was a concept, but no plan. Military and key personnel would either shelter-in-place or go to Fort Dix in New Jersey. Others were to be provided for by the County. There was little participation in planning and exercising this concept with Orange County or other jurisdictions.

This estrangement from local jurisdictions and the State ended recently. A firm that worked with the Orange County planning effort has been engaged to assist in the development of a West Point all-hazards plan that emphasizes Indian Point. A plan suitable for testing is due January 30, 2003, and tabletop exercises will then be held. FEMA, the State, and the County are expected to participate in this process.

As a consequence of the above, little more can be said at this point, except to emphasize the importance of Indian Point including West Point as a recipient of the direct, immediate, and continual information flow recommended for local jurisdictions elsewhere in this report.

Use of West Point cadets and military resources as a source of assistance to local authorities in the event of an accident at Indian Point was broached with West Point officials. They considered such use to be inconsistent with their primary mission(s) because it jeopardized the health and safety of their cadets.

4.5.5 Public Works

Those few public works officials contacted expressed concerns similar to those pessimistic opinions described for law enforcement and fire services above. Salient among these was concern about radio communications capabilities and the inadequacies of the road networks. A notable exception was optimism that public works employees would report in time of an incident at Indian Point, just as they do in the foulest weather. In addition to the generally negative views about the practicality of the plans, we heard about the need for backup power systems, the lack of equipment and personnel to effectively manage multiple traffic control points, the consequent impracticality of reversing lanes, the impact of weather on plans with an evacuation component, and the inability to clear roads of accidents where there are no shoulders.

4.5.6 Transportation

A number of transportation officials were interviewed, including those from Westchester Department of Transportation, White Plains Bus, Haverstraw Transit, and Putnam Valley School District. The insights gained from these interviews were supplemented by discussions with School District Supervisors, emergency planners, advocacy groups, and elected officials. In general those responsible for the transportation of school children were more buoyant about the prospects for successful (if significantly delayed) accomplishment of their mission than were most others, with the exception of emergency planners who tended to share their optimism. Many used local drivers who knew the roads, and knew the children. Most drivers were expected to perform their emergency responsibilities, including making a second evacuation run.

The main problem identified was parents making orderly and prompt evacuation impossible, especially for schools with only one entrance suitable for buses. One company reviewed aerial photos to see if children could walk to adjacent roads to board the buses. Managers felt their driver training programs to be adequate, and that their drivers were proficient in English. Several told of successful experiences in events they thought to be comparable, though on a reduced scale. One mentioned that in one evacuation, police did block the entrance to the school and handed parents a paper that said where the children were being taken. Those interviewed felt there was sufficient redundancy in their fleets to provide the number of buses required and that their radio communication with buses was adequate. Some were concerned that if the phone system were saturated they may not receive timely notification from the county.

For general evacuation, reaching drivers after hours may be problematic, but could be partially solved by the issuance of pagers. Similarly, the ability of supervisors to receive notice from the County after hours troubled some. In addition, concerns were expressed regarding the narrowness of roads, the likelihood that drivers would first take care of their families, adverse weather conditions, the effectiveness or lack of police control of traffic and the navigability of unfamiliar routes in the dark.

4.5.7 Schools

Our attempts to obtain a feel for the sentiment within the school communities led to interviews with School District Supervisors, PTA officials, School Board members, and parents. Advocacy groups, emergency planners and elected officials invariably discussed schools as well. The difficulty of evacuation due to the condition of roads, the likelihood of shadow evacuation, and the expected behavior of parents was invariably expressed. The problems posed by the timing of the notice to evacuate were frequently expressed. For example, whether children are on the way to school, in class, on the way home, etc. makes a big difference. The availability of buses was not often of major concern in this regard.

Most districts are notified by the county EOC, or through a phone chain among Superintendents, but some receive notification from the plant. Most districts then use a call down system involving sequential notification by phone. Although each district is supposed to have satellite communications, we believe the issue of effective notification is important for the Counties to carefully review, in close concert with those to be notified. This review must include consideration of those using school facilities after normal school hours, private schools, head start, day care facilities, etc.

We discussed with members of the school community some alternatives to the current plan for evacuation. While placing buses near the school populations served, to be driven by school employees, would dramatically improve the prospects of effective evacuation, the costs of such a solution precluded its serious consideration in all but the most extreme conditions. Similarly the construction of a facility that, through over-pressurization and other measures, is adequate for temporary shelter-in-place, was thought to be an expensive solution likely to be defeated by parents who do not understand its advantages and would still retrieve their children. Encouraging neighborhood groups to agree among themselves and arrange with the schools that any of them can pick up the children of others, while it has practical difficulties, would reduce the numbers of children to be bused. Also, some districts encourage and support such arrangements now. But it would only reduce the numbers of those to be evacuated by bus, and therefore would not solve the busing problem. Allowing parents two hours to pick up their children before the buses take them away was an idea favored by some parents but, again, does not solve the busing problem and would also lengthen the evacuation times significantly.

As is the case with other supporting institutions, school officials felt that some employees may leave to care for their families. Also, as is the case with other supporting institutions, there has been no training in family protection planning and little significant involvement in past Indian Point exercises. However, out of sequence drills and interviews with school personnel (and with other supporting institutions like congregate care center personnel) are conducted as part of the exercise process, and these drills and interviews may properly be considered as part of the training effort.

A unique apprehension among school officials is the responsibility to administer KI to children, because of administrative difficulties, staff training, liability and the possibility of adverse reactions. School officials and parents expressed unease about multiple relocation centers for schools. That issue has been recently addressed and corrected for some districts in Westchester County. No instances were found of schools having evacuation kits for children that contained medicines, water, clothing, etc. Finally, that some relocation centers are on the fringe of the ten mile zone is a legitimate concern that should be addressed by planners.

CHAPTER 5
EMERGENCY PLANNING BASES AND SYSTEMS

Planning is based on an understanding of the hazards that might occur, the effect of these hazards on people in the area, which strategies can best protect the population, and the emergency resources available for response. Understanding and assessing the hazard was discussed in Chapter 3. The heart of this review lies in the review of the emergency plans of the plants, and of the states and jurisdictions involved in emergency response. This review encompassed consideration of the validity of the information that the plans were based on, such as population data, evacuation time estimates, alert and notification system specifications, and dose assessment methodologies. It also included review of the communications capabilities of those involved in a response at Indian Point and how well the plans fit together to produce a coordinated and effective response. Resource management and command and control capabilities were also salient aspects of this review effort.

Protecting people from a radiological release requires an understanding of how the population changes in time and space. People will be in different places throughout the course of a day, as they move from home to work and back. On the weekends, this pattern will change. Population databases provide information on where people reside, work, and recreate and how many people can be expected to be at various locations at different times of the day and night.

Evacuation is the principal strategy for protecting people from initial radiation hazards. If an evacuation of an area at risk can be completed in time, it will prevent the population from exposure to the airborne radiation released during an accident. Sophisticated computer models are available to simulate the evacuation of people during an event. These models provide an indication of how long evacuation may take under varying circumstances—good and bad weather, night and day evacuation, etc.—and also show where traffic congestion may be a problem.

Alert and notification equipment is a crucial part of the overall emergency response system for radiological accidents. For these kinds of accidents, the public will not receive visual or other cues that a radiological emergency has occurred. Thus, one of the primary goals of radiological emergency management is to provide accurate, timely, and meaningful warning to the public that an accident has occurred. Alert and notification systems provide these warnings.

Communication is the lifeblood of emergency operations. Any emergency at Indian Point will involve hundreds of emergency personnel from the facility, the State of New York, and the counties of Orange, Putnam, Rockland, and Westchester. A release at Millstone will likewise involve New York State and county personnel, with the added dimension of a large coordination challenge of integrating the response with Connecticut jurisdictions. Additionally, there will be a need for communication and coordination between the agencies around Indian Point or Millstone and other agencies, such as the Nuclear Regulatory Commission, the Environmental Protection

Agency, and FEMA. Rapid, continuous, and error-free communication will be even more crucial during a radiological event with an accelerated timeline.

Communication systems are also the basis for decision-making. Information from the field, Emergency Operations Centers, reception centers, and a myriad of other sources will need to be quickly integrated with facility predictions of the release and its potential consequences. Each emergency responder may contribute parts of this information. An integrated situation assessment forms a sound basis for proactive decision-making. However, this entire structure of coordination and decision-making rests on the ability of emergency personnel to communicate quickly, continuously, and accurately.

NUREG-0654, Revision 1, outlines requirements in each of these areas. Our analysis in the following sections refers to NUREG-0654, where pertinent.

5.1 Population Basis Review

There are both regulatory compliance and strong emergency management reasons for using accurate and up-to-date population numbers to support radiological preparedness activities at a nuclear energy facility and in the surrounding civil jurisdictions. NUREG-0654 (paragraph II J and Appendix 4) contains specific requirements for the licensee to develop and maintain maps showing the distribution of people in the area around the plant and to use current population data to support evacuation time estimates.

Accurate, up-to-date population counts are important in determining the scope of impact of an accidental release (how many people could be affected and where they are located). The population numbers and the distribution of the population (where the densely populated areas are versus less populous) are also critical to support evacuation time estimates, which should be used by emergency managers for response planning as well as for making decisions during an actual emergency. If population data is incorrect or outdated, evacuation time estimates can be off by a significant amount and cause response decisions (e.g., determining the best protective action during an accident) that *might* not be in the best interest of public health and safety.

5.1.1 Determining Accurate and Up-to-Date Population Data for Indian Point

The population surrounding Indian Point is a dense mix of permanent residential, business, and recreational populations. The plume emergency planning zone encompasses parts of central and northern Westchester and Rockland Counties and southern Putnam and Orange Counties. The densest populations occur in the southern portion of the ten-mile emergency planning zone, in Westchester and Rockland Counties. A significant portion of the southern ten-mile emergency planning zone population commutes to New York City or other parts of Westchester County for work. However, a large number of businesses are also found in these areas.

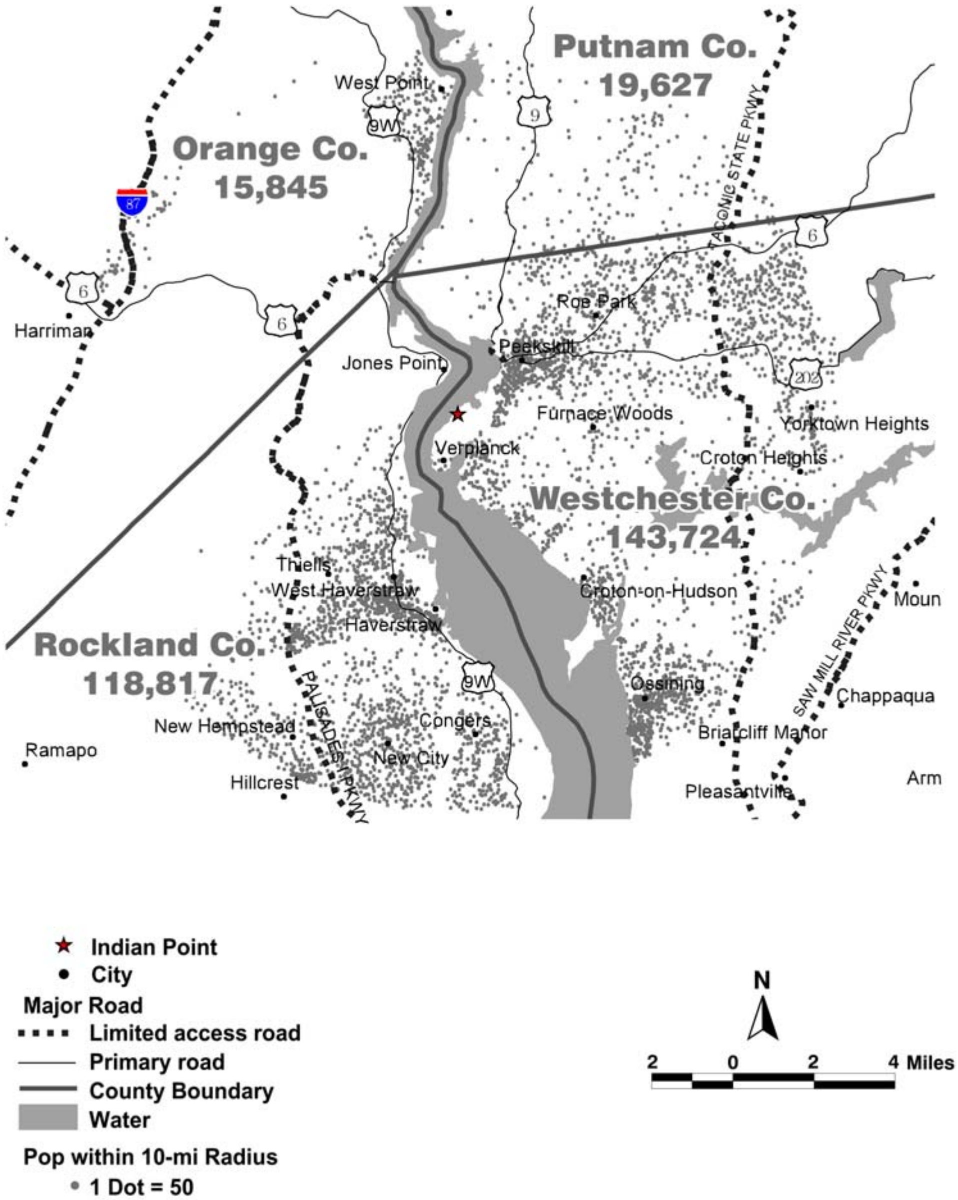

Figure 5-1: Population Density within 10-Mile Radius Around Indian Point

The ten-mile emergency planning zone around Indian Point contains several large recreational facilities and other special attractions. Among them are Bear Mountain State Park, Harriman State Park, and the U. S. Military Academy at West Point. In addition, there are several smaller state parks and county parks and attractions such as the Storm King Art Center. The Hudson River is a recreational destination in itself and attracts visitors who may stay at various hotels, motels, or inns around the area.

The plume emergency planning zone surrounding Indian Point is composed of a number of planning areas that generally cover a circular area with a ten-mile radius. When the circle is used to represent the ten-mile emergency planning zone, it is normally divided into a number of 22.5

degree wedges, or *sectors*, that are identified by compass direction. For example, N is oriented north and E is oriented east with three other sectors (NNE, NE, ENE) between. One of the reasons for this method of dividing up the ten-mile emergency planning zone circle is to identify locations for off-site radiological monitoring, as described in NUREG-0654, section II J. Additional rings can also be used at distances less than 10 miles to further subdivide the sectors. This is one method used to divide the ten-mile emergency planning zone into standard increments for use in emergency preparedness activities or response. Another way to divide it is to use the emergency response planning areas that are defined by Indian Point emergency managers. The sectors in the circle and the emergency response and planning areas are two different ways to look at portions of the ten-mile circle. An example of the circle and sector method is shown in Figure 5-2.

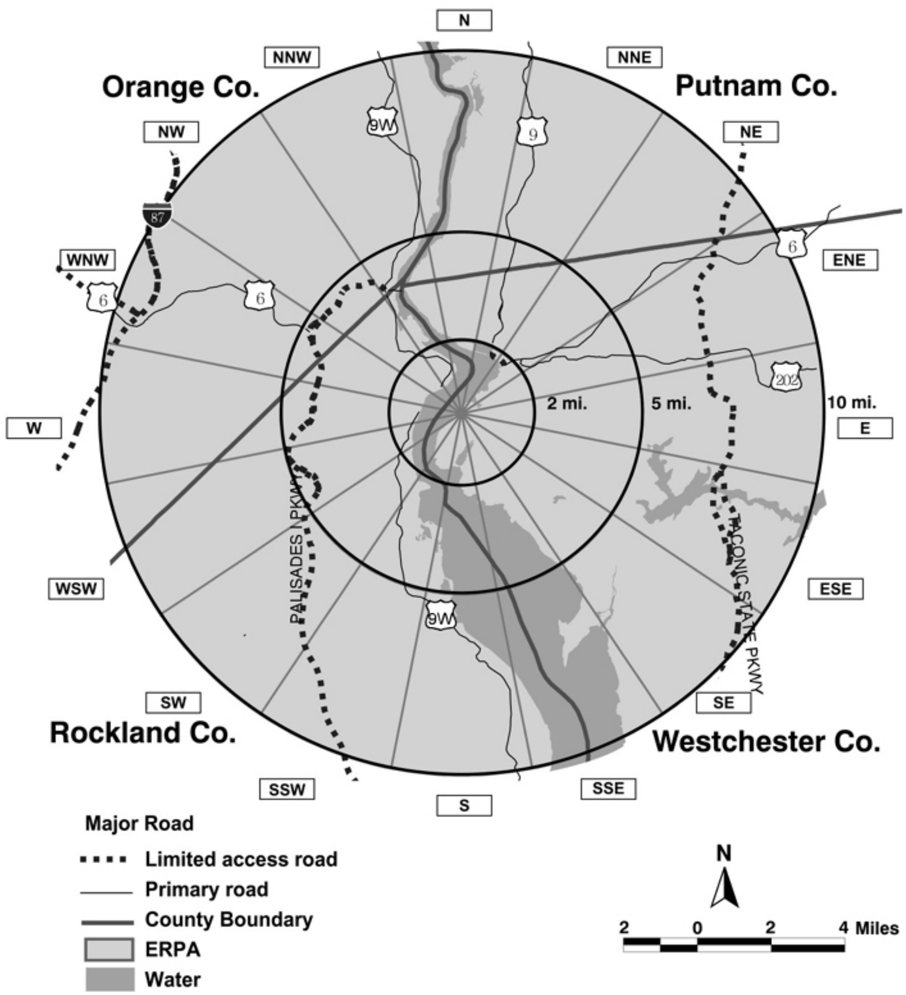

Figure 5-2: Indian Point Sector Diagram with 2, 5, and 10-Mile Radius Rings

IEM gathered data to determine population estimates and special facility populations within the Indian Point ten-mile emergency planning zone. IEM's population estimates include permanent resident populations and transient populations. In addition, IEM reviewers calculated permanent resident population estimates in concentric rings from the plume emergency planning zone to a 50-mile radius, the ingestion emergency planning zone, around the plant. This information was then compared to the population data currently in use by the licensee, counties, and state in their emergency planning. The Entergy is currently sponsoring a population update in conjunction with development of new evacuation time estimates based on the 2000 decennial census. IEM spent a greater portion of the analysis comparing the population update being conducted by KLD Associates, Inc. ("KLD"), the licensee's contractor, to an independent IEM population update. IEM obtained information from the Entergy to reach substantive conclusions based on the comparison.

The total number of permanent residents estimated to be within the ten-mile emergency planning zone is just over 298,000. The majority of these residents are in Westchester and Rockland Counties. Table 5-1 shows the permanent resident populations within the ten-mile emergency planning zone as constituted by the emergency response and planning areas in the four counties around the plant.

Table 5-1: Permanent Resident Populations within Emergency Planning Zone (EPZ) by County[53]

County	1990 Population	2000 Population	2000 Households	2000 Average Household Size	Percentage Change from 1990 to 2000
Orange	14,456	15,845	4,324	2.83	9.6%
Putnam	17,877	19,627	6,897	2.81	9.8%
Rockland	111,091	118,817	37,225	3.12	7.0%
Westchester	132,413	143,724	50,318	2.73	8.5%
Total	**277,837**	**298,013**	**98,764**	**2.89**	**7.3%**

Note that in the column that shows the county plume emergency planning zone population based on the 1990 census, the difference between the updated population and the population over 10 years ago is significant for all but Orange County. The increase in the numbers for the other counties is a reflection of business and residential growth that may also affect the distribution of the population on the map. The fact that such large changes are present underscores the need for updated data—it is directly related to effective emergency preparedness and response as previously discussed in this section. For IEM's discussion of permanent resident population by emergency response and planning area and sector, refer to Appendix D.

[53] The average household size does not equal the *population* column divided by the *households* column because the population total includes the "non-household" population. The Census Bureau classifies all people not living in households as living in group quarters. There are two types of group quarters: institutional (for example, correctional facilities, nursing homes, and mental hospitals) and non-institutional (for example, college dormitories, military barracks, group homes, missions, and shelters).

5.1.2 Residential Population Outside the Indian Point 10-Mile Emergency Planning Zone

Table 5-2 lists the permanent resident population determined by IEM within concentric ten-mile rings around Indian Point out to a 50-mile radius from the plant. It also shows the cumulative population for each of the rings. IEM compared these population numbers with the KLD population figures for the same areas. The New York population numbers determined by IEM and KLD for the areas outside the Indian Point ten-mile emergency planning zone are consistent.

Note that the population for the ten-mile ring in Table 5-2 is somewhat less than the number cited for the population of the emergency planning zone in Appendix D. The population within the ten-mile emergency planning zone when using the circle as the boundary is somewhat less than the total population within the emergency planning zone when totaling the populations of all the emergency response and planning areas. A number of emergency response and planning area boundaries extend beyond the ten-mile radius circle and therefore capture additional population.

Table 5-2: IEM Estimate of Permanent Resident Population within 50-Mile Radius

Radius	Ring Population	Cumulative Population
10 mile	256,439	256,439
20 mile	716,309	972,748
30 mile	1,847,198	2,819,946
40 mile	4,330,546	7,150,492
50 mile	4,631,909	11,782,401

5.1.3 Transient Population in Area Surrounding Indian Point

The transient population includes individuals who are moving into, out of, and within the ten-mile emergency planning zone for Indian Point. It is more difficult to arrive at a definitive number for the transient population than for the permanent residents. The estimates can vary based on how transient population is defined, the sources of information used to derive the estimates of transient populations, and how the individual categories of transient populations are combined to produce one number. Given the potential for variation among transient population estimates, it is important to make assumptions explicit and consistent wherever possible. If the differences cannot be reasonably explained from the assumptions, then other causes—such as the source data used—should be investigated.

Transient populations can come from outside the Indian Point ten-mile emergency planning zone or from within the zone. They can include employees working in the plume emergency planning zone, visitors to parks and other attractions, guests at hotels and motels, patients at healthcare facilities, and visitors to various types of businesses. Since some of these people represent part of the resident population totals, one cannot simply add the resident population to the transient population to get a total number of people in the ten-mile emergency planning zone at a particular time. Differentiating the two populations (resident and transient) is complex and can be affected by factors like seasonal variation (e.g., visitors to Bear Mountain State Park during summer versus winter).

IEM has analyzed transient population in a number of population and emergency preparedness studies done in a number of U.S. locations. In the case of comparative studies, IEM has found it most useful to look at transient populations in terms of “peak volume.” This means counting the maximum number of transients in a given area or for a type of facility like a hospital or business. This provides an upper bound that can be compared to assumptions in other studies such as the KLD evacuation time estimates.

By comparing the transient population numbers in this way, the State of New York can reach informed judgments on the reasonableness of transient numbers applied to evacuation cases. For example, if an evacuation modeling case assumes an average number of transients for an area such as Bear Mountain State Park, and the State is concerned about peak summer visitors that would represent a significant difference versus the average, they should scrutinize the assumption in terms of what the peak number might be. This is an important consideration in terms of the impact on evacuation time estimates for specific areas. The evacuation times can vary greatly by season, time of day, or other considerations. Whether or not a particular time estimate is used in emergency preparedness or response activities is very much dependent on the assumptions that underlie the evacuation time estimates. Transient populations complicate the issue further because they tend to be more variable than resident populations. This is also why automated tools that can help sort out the complexities of the radiological hazard, the distribution of the population and the capability of the population to evacuate may be a major enhancement to the public protection process.

IEM used several sources of information for estimating the transient population around Indian Point. Information about business locations and employment at the locations is from a Dunn and Bradstreet database. This database is updated on a quarterly basis. IEM used this database in conjunction with other publicly available sources and phone interviews to identify special facilities and gather information about the population served by and working at each of the facilities. Visitation information for the parks in the area was collected from the public agencies responsible for administering the parks. IEM applied the same “peak population” methodology previously discussed to determine the facility populations.

Tables D-4 and D-5 in Appendix D show transient population estimates by emergency response and planning area and sector, respectively, and for Millstone since 1997. These estimates represent peak transient populations because they use the maximum values of potential population at facilities and recreational areas (i.e., maximum capacities or estimates of peak usage of facilities).

Other estimates of transient populations may vary from the IEM estimates in the following ways:

- Different population may be considered in the transient population category (e.g., business day worker populations may be omitted);

- Population estimates may be specific to a time of year or week, thereby combining portions of the different components of the transient population;
- Different sources of information or assumptions may be used to estimate workplace populations.

The first two sources of variation will most likely reduce the transient population estimates versus those developed by IEM. It is difficult to determine how the third source of variation would impact the estimates because there is no way of discerning how the different data sources may be compiled, their "pedigree," timeliness, etc., and therefore, it is unknown how they will compare to the source data IEM used. Population estimates generated for specific scenarios for evacuation modeling entail a combination of some or all of the permanent resident estimates with some or all of the transient population estimates. Evacuation time estimates can vary based on these combinations.

IEM cannot envision a scenario that would require combining the permanent resident estimates in their entirety with the transient estimates in their entirety. Such a scenario would imply that (1) none of the permanent population that lives in the area leaves for work or special areas and activities outside the ten-mile emergency planning zone, and that (2) all the people from outside the ten-mile emergency planning zone that come into it for work or special activities would stay in. In reality, there are always people coming into and going out of the plume emergency planning zone for many reasons. Therefore, it is a reasonable assumption that the populations for each emergency response and planning area loaded onto the evacuation network should be lower than the combination of the permanent resident population and the transient population for that emergency response and planning area as detailed in Appendix D of this report. If the numbers used in the evacuation time estimate study are much higher, the State of New York should scrutinize the underlying evacuation time estimate assumptions carefully.

5.1.4 Special Facility Populations in the Area Surrounding Indian Point

IEM gathered population information for a number of special facilities in the Indian Point ten-mile emergency planning zone. "Special facilities" include schools, daycares, nursing homes and home care centers, hospitals, prisons, large hotels, and large employers. While emergency management regulations related to nuclear energy facilities do not require explicit consideration of all the categories of special facilities listed in this report, IEM's experience with emergency management planning for other large industrial facilities as well as nuclear power plants indicates that these categories represent the types of facilities that would require special consideration in evacuation studies. Tables D-6 through D-13 in Appendix D list the specific facilities that IEM evaluated within the ten-mile emergency planning zone. As previously discussed, the population for each facility represents a peak (maximum) population, and in most cases, was obtained via phone survey of personnel at each facility.

5.1.5 Additional Observations Concerning Indian Point Emergency Planning Zone Population

The IEM and KLD resident population estimates are generally consistent, which is not surprising, given the common use of the 2000 United States decennial census numbers as a basis. Since it is unlikely that KLD will assign population to the evacuation network based on individual sector populations, the disparity noted in the resident population sector analysis is not expected to directly affect evacuation time estimates.

Transient population estimates have the potential for a much larger disparity. The transient population estimates derived by IEM are conservative because they include the high-end of any possible range of population. IEM's estimate may include some double-counting as well.[54] The key to comparing IEM and KLD transient population estimates is accounting for potentially substantial undercounts among the KLD estimates relative to the IEM counts in the context of the methodologies used to make the estimates. Similarly, given different sources of data for the special facilities, it is possible that some facilities listed in one source are not included in others. Given the importance of evacuation time estimates, the critical issue is that all of the facilities identified by IEM are included in the KLD analysis and that KLD's population estimates for these facilities are not significantly less than IEM's.[55]

The Entergy is required to develop population data for use in emergency preparedness and response, but is not required to update the data in years between the decennial census. Although complete population updates may not be required during the interim years, selected areas of growth or reduction should be captured in an effort to determine how evacuation time estimates or protective actions in general might change. The licensee regulatory requirement to simply have "maps" of the population distribution around Indian Point does not provide much incentive for the licensee or anyone else to explore and implement newer technology that would enhance the utility of population data in planning and response. An example would be computer systems that could dynamically determine the threatened population, intersect that with the hazard in terms of the arrival time of critical dose and thereby determine the best protective action through use of the population distribution, the evacuation time estimates and other factors. See Appendix D for a more expanded discussion of this concept.

The civil jurisdictions responsible for Indian Point radiological emergency preparedness also lack a strong incentive to do anything with population data other than what the licensee gives them. For the off-site radiological emergency preparedness jurisdictions, there is not a regulatory requirement pertaining to Emergency Planning Zone populations. In general, population updates are not emphasized from the protective action decision making perspective in plan reviews or exercising. This is an important observation in that there is no easy way to "scale" population or evacuation time estimates when emergency management officials need to make decisions during a response. For example, Westchester County made an estimate as to how the evacuation time estimates increased for areas of the county during the response that played out in the September 24 full-scale exercise for Indian Point. It is commendable that this county attempted an estimate rather than simply use dated information, but they could not have total confidence that the scaling was correct—and the county population data provides the foundation for such scaling.

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[54] For example, IEM calculated the transient population by summarizing employment information from a business location database and adding that to other information, such as recreational population number, which includes park-users. In fact, some of the employees from the business location database may also be using the parks, but IEM does not have the resolution in the data to eliminate all possible double-counts. Populations are not mutually exclusive.

[55] IEM was not able to evaluate KLD's transient population assumptions or numbers of people directly, or compare lists of facilities between the two studies. IEM assumes this information will be published in or with the KLD evacuation time estimates. The intent of this report is to provide guidance to applicable reviewers who want to compare transient population numbers and facility lists once the ETE report is published.

The licensee, state, and county observations have important public safety implications, so the evacuation time estimate update currently ongoing for Indian Point should have a positive impact. At a minimum, the jurisdictions that are using the information in planning and response will have the benefit of better data, provided it is accurate and the respective emergency managers are confident in the underlying assumptions and population numbers. There are several counties that do not appear to be using the population or evacuation time estimate data in their response activities.

5.1.6 Population Analysis for Millstone: New York Population in the 10-mile and 50-mile Emergency Planning Zones

The Millstone population analysis focused on the New York population in the 10 and 50-mile emergency planning zones. Since the Millstone plant is located on the southern shore of Connecticut, about half of the ten-mile emergency planning zone covers the open water of Long Island Sound. IEM characterized only two New York populated areas in the ten-mile Millstone emergency planning zone—Fishers Island and Plum Island. A significant portion of the 50-mile emergency planning zone is also over water, especially in the area of the circle that captures New York population. Since this analysis focused only on the New York population in the Millstone emergency planning zones, the relative quantity of population information reported here is much less than detailed above for Indian Point. The resident, transient and facility populations are consolidated for each area in the following sections. Because of the smaller amount of information, there are no expanded tables in the appendix as with Indian Point. The same methods and sources of data were used to determine residential, transient and facility populations for Millstone. Where information was not available in the sources used to analyze Millstone, interview data collected for specific locations was used in its place.

For example, the Plum Island residential population is listed in the 2000 US Census block data as zero. This is because Plum Island, a federal parcel of land managed by the US Department of Agriculture, does not have permanent residences on the property. There is however a population of workers that occupies the island to conduct the USDA mission there. A large fraction of these workers are New York residents. James Lee Witt Associates obtained information on the Plum Island worker population for that reason (along with additional radiological emergency preparedness planning information). The Plum Island workers, even though they are considered the responsibility of the federal agency, effectively represent a New York transient worker population in the ten-mile Millstone emergency planning zone.

The figure below shows the ten-mile emergency planning zone circle for Millstone with applicable New York populated areas highlighted. The area surrounding the Millstone plant is further divided, based on the Connecticut State radiological emergency preparedness plan, into individually identified sub-areas in a manner similar to the emergency response planning areas for Indian Point. However, there are only six areas, identified simply as lettered "zones" A through F for Millstone. Each of the lettered zones for Millstone covers a larger portion of the ten-mile emergency planning zone than the Emergency Response Planning Areas for Indian Point. Zone F is the only one identified for New York population, covering Fishers Island. Plum Island is not assigned a zone identifier. This effectively isolates the New York population for the ten-mile emergency planning zone in the State of Connecticut plan to Fishers Island.

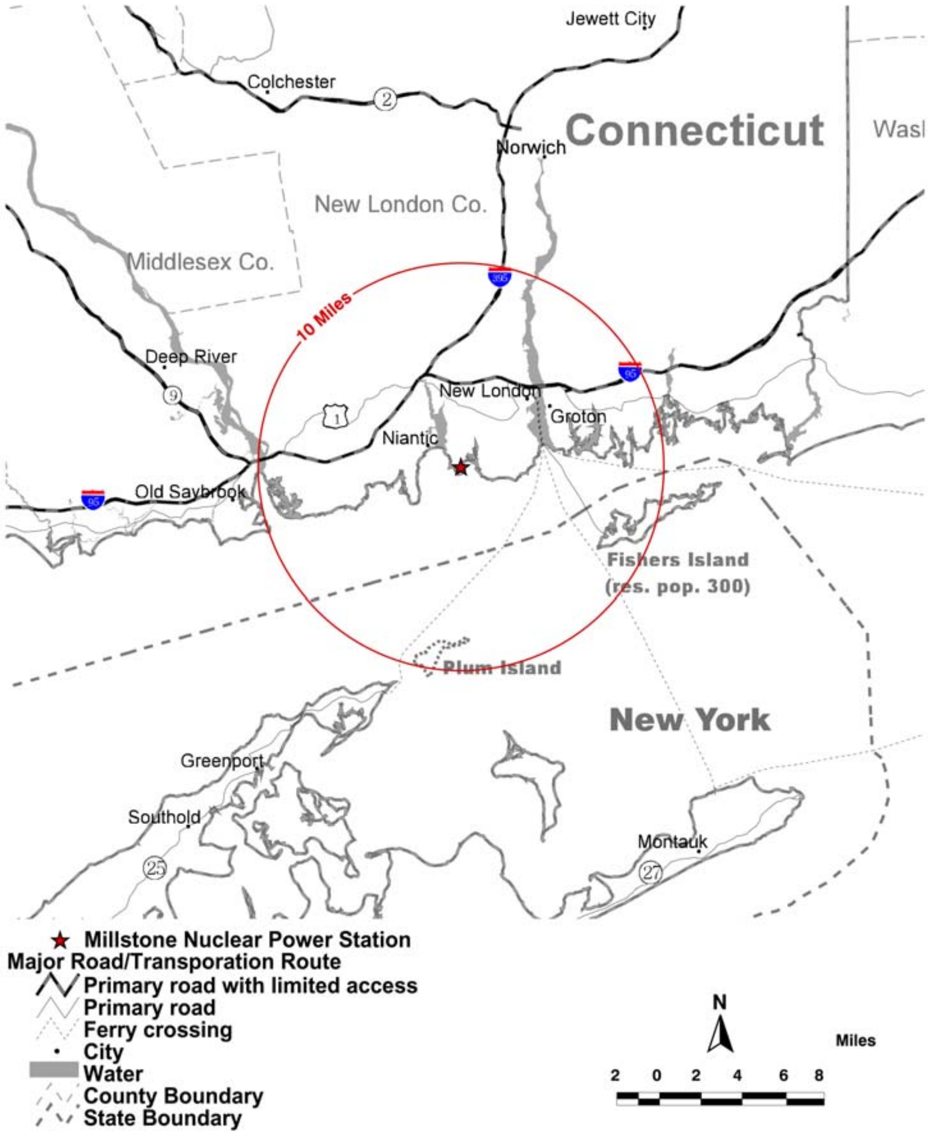

Figure 5-3: Map of 10-Mile Emergency Planning Zone for Millstone

5.1.6.1 Fishers Island Residential, Transient and Special Facility Population

Fishers Island is a small resort island that lies approximately two miles (closest point to closest point) off the southern coast of Connecticut. It is oriented southeast of New London and is approximately 8 miles line distance from the Millstone plant. In the summer months the island's resident population swells to roughly 15 times the size of the remainder of the year. The transient population increases in the summer as well, mainly additional day workers. In the summer months, both resident population and transients access the island by ferry, airplane or private boat. Table 5- shows the seasonal populations based on interviews with responsible Fishers Island officials.

Table 5-3: Normal and Summer Populations for Fishers Island

	Summer	Fall, Winter, Spring
Resident Population	4,000+	300
Transient Population	175	125

There is only one school on the island that serves a student population of 55-60 students year to year. The school has a staff of 12 people. The only other non-resident structure on Fishers Island that might be considered a "special facility" as defined in the appendix tables for Millstone is the Pequout Inn, a small seven-room hotel.

5.1.6.2 Plum Island Worker Population

Plum Island lies in Long Island Sound approximately 8 miles due south of the Millstone plant. Plum Island Animal Disease Center is an 800 acre facility wholly under the jurisdiction of the Federal government. The worker population varies between approximately 200 and 300 people at the facility. Primary transportation to and from the island is by boat and the Disease Center has a number of boats in their equipment inventory. The worker population at Plum Island is generally divided into non-essential personnel that would be evacuated by boat in a radiological emergency and 6 to12 essential personnel that would remain on the island to perform critical activities. These essential personnel have specialized training and both protective and radiological monitoring equipment available to perform their mission in an emergency.

5.1.6.3 New York Population Within the 50-mile Millstone Ingestion Emergency Planning Zone

The estimates of residential population within the concentric rings out to a 50 mile radius from the Millstone plant were determined using the same methods as for the Indian Point Ingestion emergency planning zone. The 50-mile radius around Millstone covers large areas in Connecticut and Long Island Sound. Figure 5-4 shows Millstone's 50-mile emergency planning zone.

Figure 5-4: 50-Mile Emergency Planning Zone for Millstone

The New York population within the 50-mile radius is comprised of the Fishers Island and Plum Island populations already discussed, plus a large portion of Suffolk County on Long Island. Table 5-4 shows the permanent resident New York population for each ten-mile concentric ring within the Ingestion emergency planning zone radius. The cumulative population is also provided. This is the total population of the ring plus all people in the smaller rings that precede it in the table. Note that the resident population listed for the ten-mile ring (266) is different than the population for Fishers Island detailed earlier. This is because some of Fishers Island extends outside the ten-mile circle. When census blocks are totaled within the circle, some of the Fishers Island population is not counted.

Table 5-4: New York Residential Population in the 50-Mile Emergency Planning Zone

Ring	Residential Population in Ring	Cumulative Population
0-10 miles	266	266
10-20 miles	9,741	10,007
20-30 miles	43,545	53,552
30-40 miles	53,974	107,526
40-50 miles	109,029	216,555

The preparedness impacts of the Millstone population data are generally the same as for Indian Point. In other words, if there are significant differences between the current numbers developed for this report and numbers being used to support planning or response operations (number of people to evacuate Fishers Island in summer versus ferry emergency loading capacity for example), then plans and the resultant implementation impact on public safety can be affected. The major difference noted in the respective population reviews for the two nuclear facilities was the fact that Indian Point is currently undergoing a major population update in conjunction with a revised evacuation time estimate study. The population numbers being developed for that evacuation study are in good agreement with the numbers developed independently in this report. There is not a similar comparison that could be done for Millstone. It is not clear when the population data supporting plans at Millstone will be updated or when revisions to plans will be accomplished based on such an update. The State of New York may want to review possible impacts on a case by case basis with the State of Connecticut to ensure up to date population figures are factored into preparedness planning.

5.2 Evacuation Time Estimate Review

When responding to a radiological emergency, there are two basic forms of protective actions that emergency managers can instruct the public to take—**evacuation** and **sheltering**. Evacuation is typically the preferred method of protection, as it removes the public from the dangerous area altogether. Sheltering only minimizes the exposure of the public to the airborne hazard. Sheltering is, however, quick to implement relative to evacuation and can provide protection for short time periods.

Making the decision to evacuate or shelter the public once a release has occurred is a difficult decision that depends on several factors, such as the number of people in the affected areas, the amount of time it will take the plume of radiological material to reach those people, and how long it would take to evacuate those people. For a successful evacuation to occur, the population must clear the affected area before receiving a critical dose of radiation as specified in federal guidelines. As discussed in the previous chapter, current and accurate population databases can tell emergency managers how many people are in the area that will be affected. The evacuation time estimates[56] will inform emergency managers of approximately how long it will take to evacuate the population from the area.

Protective action decisions need to be made quickly so people can complete evacuation steps or take shelter before the hazard becomes harmful. It is therefore critical that evacuation time estimates used to support such decisions are accurate and that both decision-makers and the public trust them.

In 1979, the Nuclear Regulatory Commission implemented Title 10 of the Code of Federal Regulations, Part 50.47[57], which made the availability of an evacuation plan a condition for every nuclear power plant in the nation. Additionally, NUREG-0654 requires the inclusion of evacuation time estimate studies in all evacuation plans. These studies are the responsibility of nuclear plant operators. There is no specific requirement for how often evacuation time estimates must be updated, but as mentioned in Section 5.1, NUREG-0654 (paragraph II J and Appendix 4) requires the licensee to use current population data for evacuation time estimates. Therefore, when new census data becomes available or significant demographic changes occur in the ten-mile emergency planning zone, it is important that evacuation time estimates be recalculated using the new information.

Sophisticated traffic models currently exist that can estimate the amount of time it will take to evacuate a particular population. These models require estimate of the population in the area, the current road network, the number of cars likely to be on the network, road conditions, weather conditions, and other factors. For *planning* purposes, these models can help to predict whether an evacuation can be successfully completed for a variety of emergency scenarios. During *response*, evacuation time estimates will be critical to determining whether there is enough time to evacuate the population before they are exposed to radiological material.

5.2.1 Review of Available Indian Point Evacuation Time Estimates

The feasibility of evacuating the large number of residents near Indian Point in the event of a radiological release has been an area of increased concern among populations living within the Indian Point plume emergency planning zone, several advocacy groups, and Senate committees. These groups assert that current evacuation plans for Indian Point are based on incorrect population data, do not adequately account for transit-dependent populations, and make several assumptions that do not reflect realistic data (refer to Appendix J of this report for a more complete listing of these issues).

KLD has been contracted by the licensee to develop the data and perform the analyses required to generate evacuation time estimates for Indian Point. IEM was tasked to independently verify KLD's input data, underlying assumptions, and methodology, in order to establish the validity of the evacuation time estimates that will result. As the evacuation time estimates were not

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[56] Evacuation time estimates are also referred to as *evacuation travel time estimates* in some texts. For the purposes of this report, the term *evacuation time estimate* will be used.
[57] RIS-01-016 - Update of Evacuation Time Estimates.

complete at the time this report was published, a technical review of the estimates themselves was not possible.

Specifically to address some of the concerns being raised about evacuation at Indian Point, IEM reviewed the rates KLD used to represent *mobilization time*, or how quickly the population begins to evacuate after being told to do so, and studied KLD's treatment of *shadow evacuations*, or evacuations by people who are not in the affected area and have not been told to evacuate. Using slower mobilization times will result in longer evacuation time estimates, while faster times will cause shorter evacuation time estimates. The added traffic caused by shadow evacuations can result in increased network congestion that slows down the entire evacuation. Traffic loading rate, used to represent how quickly cars load onto the network, is also an important factor in developing evacuation time estimates. However, this rate was not available at the time this report was published and therefore could not be reviewed.

5.2.2 Review and Analysis of Indian Point Evacuation Time Estimate Methodology

KLD collected available data regarding demographics through readily available and reliable sources such as the U.S. Census. They also conducted a telephonic survey to collect additional demographic information for the population in the ten-mile emergency planning zone and to gather data that would facilitate an understanding of the behavior of the population in the event of an evacuation.

KLD used the software system IDYNEV to estimate evacuation travel times at Indian Point. The software consists of three functional components, including a traffic assignment model (called "TRAD"), a traffic simulation model, and a traffic capacity sub-model. TRAD identifies the best travel routes for individuals in vehicles to move from specified locations ("origins") within the ten-mile emergency planning zone to locations just outside the zone ("destinations").

KLD's methodology for developing evacuation time estimates for Indian Point follows. The process is also illustrated in Figure 5-5.

- Obtain demographic data for the ten-mile emergency planning zone in the form of census data. The updated data for the various categories of populations within the plume emergency planning zone is then determined from the census data. (IEM's review of the population data used by KLD was discussed in Section 5.1.)
- Study a high-resolution map of the ten-mile emergency planning zone. This enables identification of access roads from each residential development to the adjoining elements of the analysis road network, and allows KLD to assign generated trips to the correct links and to properly represent complex intersection configurations.
- Conduct a physical survey of the roadway system within the ten-mile emergency planning zone at Indian Point. The purpose of this survey is to gather the properties of the road links and intersections and to gain the necessary insight required for estimating realistic values of roadway capacities. This information is then used to develop the evacuation network representation of the physical roadway system.
- Determine an estimate of the capacities of each link and the location of the centroids where trips will be generated during the evacuation process.

- Create the input stream for TRAD. This model is designed to be compatible with the traffic simulation model used later in the project.
- Execute TRAD. Sources of error are identified, and the necessary corrections are made. The traffic assignment model is then executed again with the input stream that is free of error.
- Examine statistics produced by the traffic assignment program. “Hot spots” in the network with extreme congestion are identified. Any treatments necessary to resolve the congestion problems are applied. This will result in modifications to the input stream. TRAD is executed again. This process is repeated until the results are satisfactory.
- The traffic assignment output is used to complete the input stream for the traffic simulation model.
- Execute traffic simulation model. It provides the user with detailed measures of effectiveness that describe the detailed performance of traffic operations on each link of the network.
- Examine the detailed output of the traffic simulation model in order to identify the problems that exist on the network. If traffic flow is considered to be less efficient than is possible to achieve, corrective treatments can then be designed to expedite the flow of traffic on the network.
- Implement changes in control treatments or assignments of destinations associated with one or more origins in order to improve the flow of traffic over the network. These treatments can also include the considerations of additional roadway segments to the existing analysis network in order to disperse the traffic demand.
- Modify the input stream once the treatments have been identified. The simulation model is executed once again.
- The simulation results are analyzed, tabulated, and graphed. The results are documented, as required.

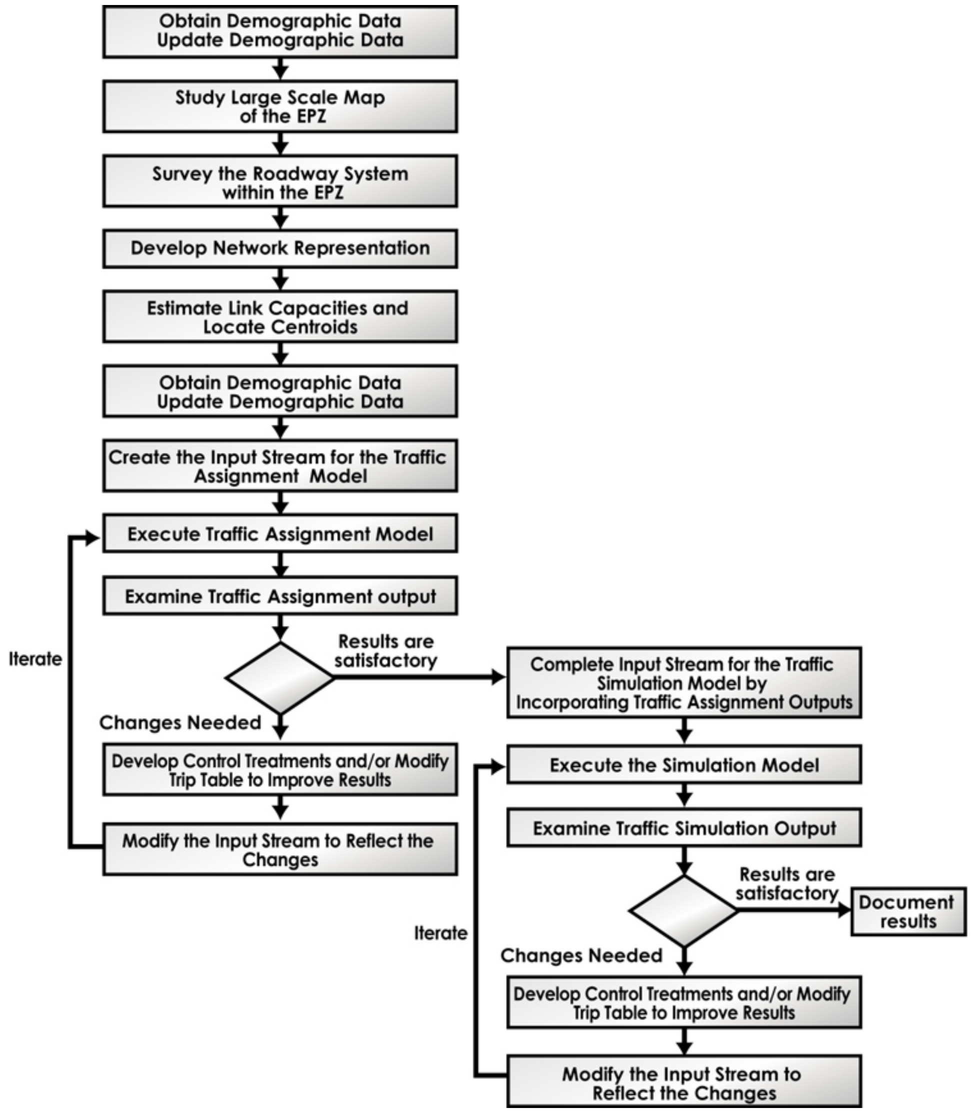

Figure 5-5: Flow Chart of KLD's Methodology for Generating Evacuating Time Estimates

The traffic simulation model describes the performance of the vehicles traveling on the roadway network during the evacuation of an area. The traffic capacity sub-model, which services both TRAD and the traffic simulation model, computes the rates at which vehicles can exit evacuation roadways.

IEM's assessment is that KLD's process for generating evacuation time estimates is fairly standard and if done correctly, should generate valid evacuation time estimates that will be useful in making protective action decisions.

5.2.3 Mobilization Times and Shadow Evacuations around Indian Point

Three factors largely affect evacuation time estimates—mobilization times, traffic loading rates, and shadow evacuations. KLD used the results of a recent telephone survey[58] to estimate the range of mobilization times for vehicles during an emergency evacuation simulation. IEM compared mobilization curves that were derived from data presented in *Evaluating Protective Actions for Chemical Agent Emergencies*[59] to the data presented in the KLD report. The Oak Ridge National Laboratory data was collected during evacuations executed in response to three large-scale chemical spills and explicitly incorporates the time required for an individual to respond to a warning and prepare to evacuate. The data collected for each evacuation was based on a combination of three population types—transient, permanent, and special population—and is appropriate to use as general warning diffusion and mobilization curves for all population types. It is therefore comparable to the data that was collected by KLD in their phone survey.

Based on the overlay of the mobilization curves (seen in Figure 5-6), it appears that the survey data KLD collected is consistent with the data collected during the chemical accidents in Mississauga, Confluence, and Pittsburgh, which are cited in the Oak Ridge National Laboratory study.

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[58] The KLD survey was conducted in June 2002 by First Market Research for the "Indian Point Evacuation Time Estimates Study." The report, which contains the results of the survey, was prepared by KLD for Entergy Nuclear Northeast.

[59] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615), Oak Ridge, TN: Oak Ridge National Laboratory.

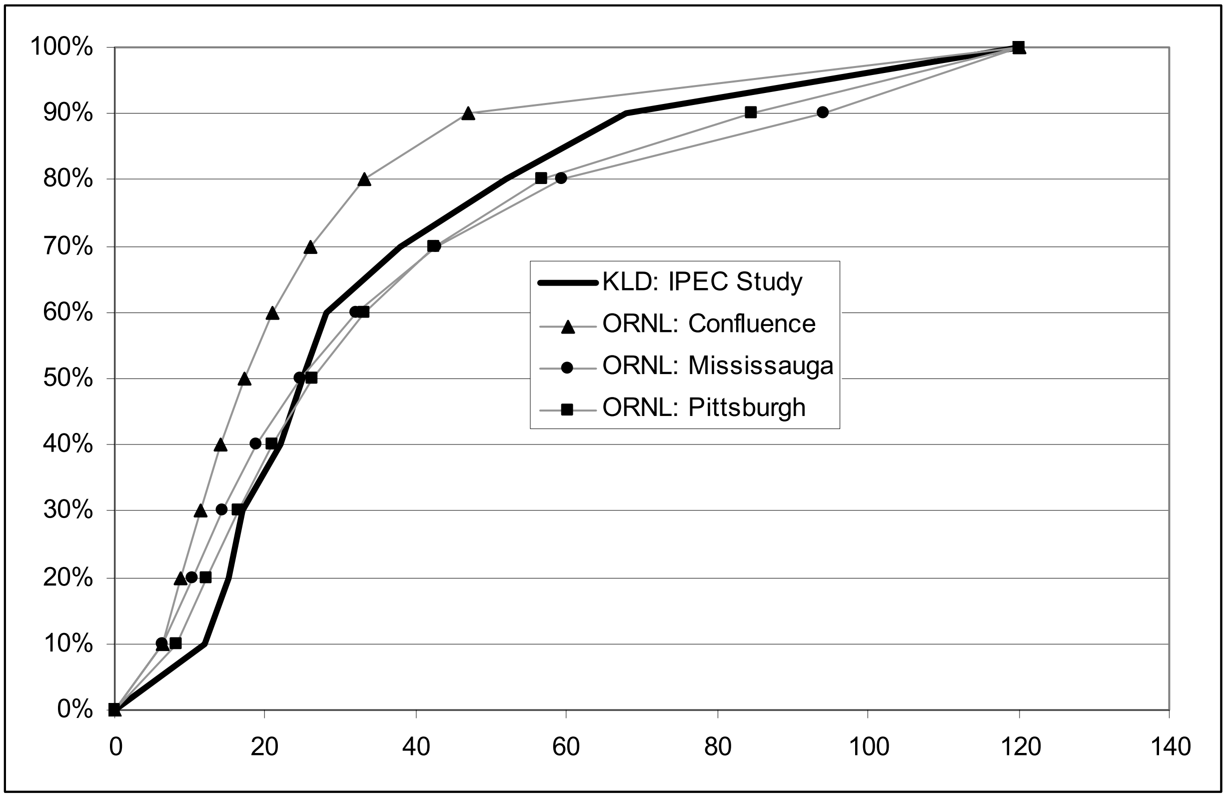

Figure 5-6: Comparison of KLD to ORNL Mobilization Estimates for Different Cities

Based on a review of assumptions supplied by KLD, shadow evacuation was treated as indicated in Figure 5-7. A summary of the assumptions employed follows.

Evacuations are directed in the wedge identified based on direction and distance. An unordered voluntary evacuation of 50% of the population out to the same distance as the wedge, but not **in** the wedge is expected to occur. The ring between the wedge distance and the ten-mile emergency planning zone will experience the same phenomenon to a lesser extent, only having 25% of the population spontaneously evacuate. Finally, the area between the ten-mile emergency planning zone and the bounding interstate highways will experience a 10% spontaneous evacuation. By using these assumptions, IEM believes the effect of shadow evacuation will be modeled accurately and effectively.

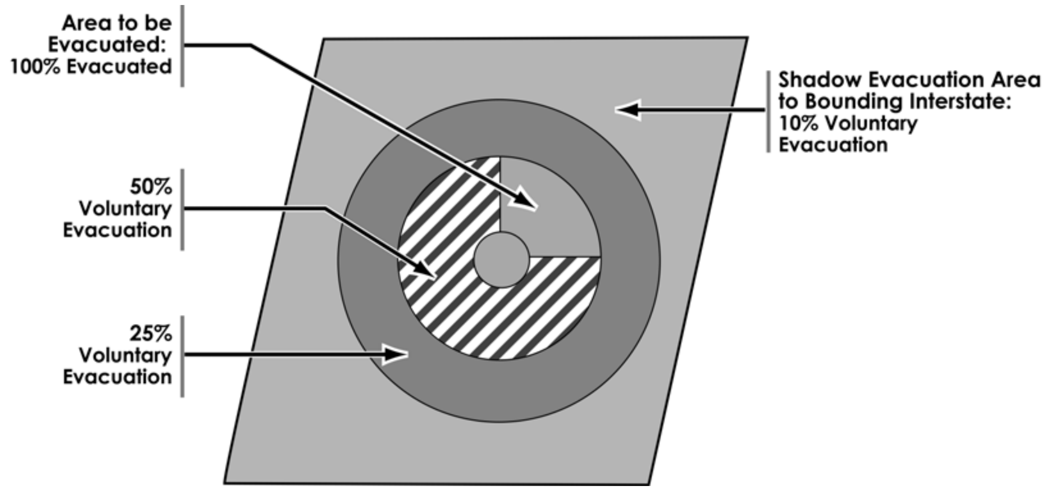

Figure 5-7: Shadow Evacuation Compliance

KLD's treatment of shadow evacuations is consistent with documented discussions[60] with Dr. John Sorenson of Oak Ridge National Laboratory, Dr. Dennis Mileti of the University of Colorado, and Dr. Michael Lindell of Texas A&M University. Dr. Mileti has spoken explicitly about using public education to reduce the impact of shadow evacuation. He commented that areas that have been sensitized to the potential for evacuation, such as those prone to disasters, tend to have a higher compliance with instructions and thus, a lower incidence of shadow evacuation.

5.2.4 Observations Concerning Evacuation Time Estimates for Indian Point

IEM conducted a field survey of the designated evacuation routes for the counties of Westchester, Putnam, Rockland, and Orange to review the Indian Point evacuation network. For this review, IEM personnel collected two specific roadway characteristics—the number of lanes and speed limits for designated evacuation roadways. These two characteristics tend to be the most important when establishing the validity of a modeled network. The other aspects that have a great deal of importance are link geometry and length, but since this data was not provided to IEM for review, the number of lanes and speed limits were the aspects evaluated.

For some sections of highway, KLD and IEM differed in the number of lanes reported to be available. Also, IEM documented some speed limits that differed from KLD's. Generally, this difference was found when KLD reported a speed limit to be 30 miles per hour, and IEM reported a speed limit of 55 miles per hour for the same section of highway. Using the slower speed limit would obviously result in longer Evacuation Time Estimates and would tend to cause a decision-maker to use sheltering more often as an appropriate protective action. The results of

[60]Discussions on file are: (1) Statement of personal communication on file between Richard Brodsky, Chairman of Environmental Conversation Committee (and John Parker, Counsel, and Chris Lee, Communications Director) and Dr. John Sorenson of the Oak Ridge National Laboratory, regarding evacuation planning for nuclear generating facilities, January 24, 2002; (2) Statement of personal communication on file between Richard Brodsky et al. and Dr. Dennis Mileti, Director of Natural Hazards Research and Applications Information Center, University of Colorado, regarding evacuation planning for potential radiological disaster, January 28, 2002; (3) Statement of personal communication on file between Richard Brodsky et al. and Dr. Michael K. Lindell, Professor at Texas A&M University, regarding evacuation planning for a potential radiological disaster, January 28, 2002.

both IEM's and KLD's review of roadway characteristics are included in Table 1 in Appendix E. Fifty-eight links were included in this table out of the links modeled by KLD.

Properties such as number of lanes and speed limits for evacuation roadways are important factors in determining evacuation time estimates. It is necessary that the evacuation plan should reflect actual field conditions if it is to be implemented effectively in the event of an emergency.

Overall, the results of IEM's review indicate that there are only a few inconsistencies between KLD's evacuation study and IEM's field survey. IEM did not find evidence that would indicate that the KLD evacuation study is invalid. Based on IEM's review, it appears that KLD has been diligent and thorough with the majority of the analysis components that IEM was able to review.

IEM strongly recommends that the areas which could not be evaluated at the time this report was published be examined to definitively establish whether the estimates produced by KLD are accurate and recommended for use in protective action decision making. If evacuation time estimates are in error in either direction (i.e., if they are estimated as too long or too short) by any significant margin, this could have a significant impact on protective action decisions made by the emergency managers at Indian Point or the jurisdictions surrounding the facility. If evacuation time estimates are too short, evacuations may be ordered when there is not time to complete the action safely, and a sheltering action would offer more protective to the public. If evacuation time estimates are too long, sheltering may be recommended in cases when there might, in fact, be sufficient time to evacuate the affected area safely.

Additionally, it is important to review how evacuation time estimates are used by Indian Point and its surrounding jurisdictions. NUREG-0654, Revision 1, requires that these estimates be developed and included as part of the evacuation plan, but there is no requirement that they actually be used in making decisions about whether to shelter or evacuate the public. Based on our plan reviews and exercise observations there are several counties that do not appear to be using the evacuation time estimates during planning or when making response decisions. Only Westchester County incorporated the evacuation time estimates provided them to make a decision about whether to evacuate or shelter the public in their jurisdiction. With the new evacuation time estimates being developed by KLD, which are based on updated population data, Westchester County will gain more current data on which to base their protective action decisions. It is important that the remaining civil jurisdictions develop a similar process for incorporating evacuation time estimates into their current method of making protective action decisions. A coordinated structured protective action decision-making process including evacuation time estimates will greatly enhance emergency preparedness at the county level.

5.2.5 Review of Available Millstone Evacuation Time Estimates

Earth Tech was contracted in 1997 by Millstone's licensee to develop the data and perform the analyses required to generate evacuation time estimates for Millstone. IEM was tasked to independently review Earth Tech's 1997 (most recent study available) evacuation time estimate study in order to establish the validity of the Fishers Island and Plum Island evacuation data.

5.2.5.1 Review and Analysis of Methodology

In this review, IEM evaluates the demographic and evacuation network data used by Earth Tech and makes some assessment as to its validity. IEM also evaluates Earth Tech's methodology and software model used in establishing the evacuation time estimates for validity and check if the model has been reviewed and/or approved by any Licensing Board. The mobilization curves for the various categories of population used in the study are evaluated. The evacuation procedures and evacuation time estimates for Fishers and Plum Islands are also analyzed. Comments and recommendations from the review and analyses are provided at the end of this section.

Earth Tech collected available data regarding demographics through readily available and reliable sources such as the 1990 U.S. Census. They also used data from a telephonic survey conducted in 1992 by Earth Tech to obtain additional demographic information for the population in the emergency planning zone such as special facilities population and transient population. Roadway geometric and operational data that were obtained in 1992 through field surveys were used in this 1997 updated study.

IEM believes that it would have been informative if a recently updated study with more current data was available for review. For example, using 2000 U.S. Census data would result in a better estimate of population, compared to 1990 Census data. A more current roadway geometric and operational data would result in better evacuation time estimates compared to 1992 data. NUREG-0654 requires that the evacuation time estimates for every nuclear plant within the nation be updated once new demographic or other data used in the evacuation time estimate study becomes available. This is required order to maintain the validity of the estimates. IEM recommends that the 1997 evacuation time estimate study be updated using current data (such as 2000 Census data) and current field survey of the evacuation network.

Earth Tech used the NETVAC software system to estimate evacuation travel times at Millstone. The NETVAC model was developed by Earth Tech specifically to provide evacuation time estimates and related information for use in emergency planning. This model has been used by Earth Tech at over 40 nuclear sites, and in states for coastal flooding scenarios. The current version of the software is called NETVAC 2. The model has been successfully reviewed at several Atomic Safety and Licensing Board hearings.

The NETVAC software program is organized in four basic units ("procedures"), including the main program, the data procedure, the preprocessor, and the simulator. The main program controls the simulation execution. The data procedure reads in the network, the parameters and the options to be used in the simulation. The preprocessor procedure converts the physical description of each link into measures of capacity, speed and density. The NETVAC simulator includes two separate procedures: the link pass and the node pass. The link pass handles the flow on the links while the node pass handles the transfer of flow from link to link.

Earth Tech's methodology for developing evacuation time estimates for Millstone follows. The process is also illustrated in Figure 5-8.

- Obtain demographic data for the emergency planning zone in the form of census data. The updated data for the various categories of populations within the emergency planning zone is then determined from the census data. Telephonic surveys are also used to collect additional demographic data.

- Study a high-resolution map of the emergency planning zone. This enables identification of access roads from each residential development to the adjoining elements of the analysis road network, and allows Earth Tech to assign generated trips to the correct links and to properly represent complex intersection configurations.
- Conduct a physical survey of the roadway system within the emergency planning zone at Millstone within the emergency planning zone at Millstone after examining the emergency planning zone map. The purpose of this survey is to gather information on the properties of the road links and intersections and to gain the necessary insight required for estimating realistic values of roadway capacities. This information is then used to develop the evacuation network representation of the physical roadway system.
- Determine the location of the centroids where trips will be generated during the evacuation process and the parameters and options to be used in the simulation.
- The main program starts by calling on the data procedure.
- Data procedure reads the network, the parameters and the options to be used in the simulation.
- Data procedure performs a set of checks on the network to ensure connectivity and validity.
- It performs a set of checks on the input data to identify coding errors.
- It produces a set of warning errors if unlikely (but possible) situations are encountered. If any errors are identified, the necessary corrections are made. Data procedure is executed again until it is free of error.
- The main program then calls the preprocessor which performs some preliminary capacity calculations.
- The preprocessor converts the physical description of each link into measures of capacities, speed and density.
- Computes the section capacity—capacity along the link regardless of downstream intersection restrictions.
- Computes approach capacity—capacity of the link to handle vehicles approaching the downstream intersection.
- The main program calls on the Simulator, which then simulates the evacuation on the network. The simulator includes two separate procedures.
- The link pass handles the flow on the links
- The node pass handles the transfer of flow from link to link.
- The main program controls the simulation itself and the reporting of the network conditions at specific intervals.
- Main program controls the rest of the reports and the length of the simulation by terminating the program once the network is empty.
- The simulation results are analyzed, and tabulated. The results are tabulated, as required.

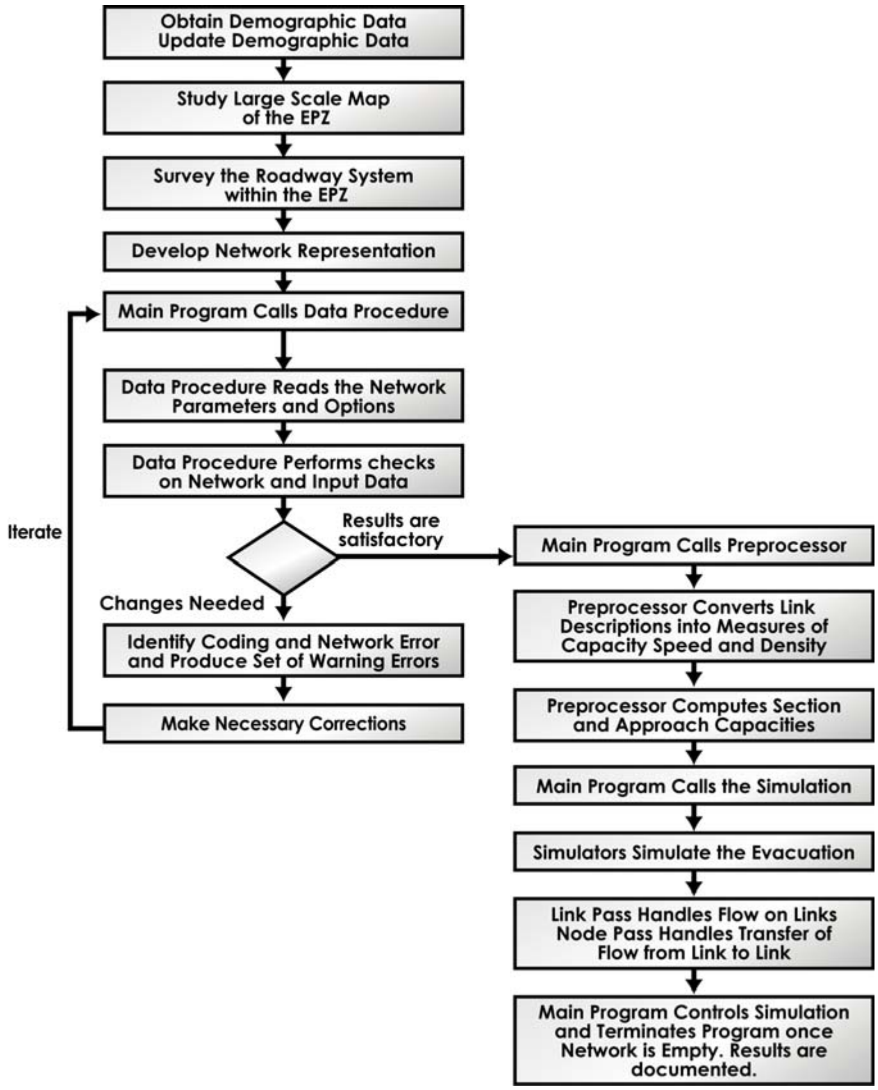

Figure 5-8: Earth Tech's Methodology for Obtaining Evacuation Time Estimates

5.2.5.2 Mobilization Times, Warning Diffusion, Loading Rates, and Shadow Evacuations for Millstone

Four of the factors that largely affect evacuation time estimates are mobilization times, warning diffusion rates, traffic loading rates, and shadow evacuation. The following section will discuss the strengths and weaknesses of each of these aspects of the Earth Tech analysis.

A notification time of 15 minutes was used in the Earth Tech study. Accordingly, in the model simulations, no vehicles will begin to mobilize until 15 minutes following the initial notification. This assumption may not be valid. Most evacuation time estimate studies assume some time for a warning to spread or "diffuse" through a population using various types of systems including

Sirens, the Emergency Alert System, and Route Alerting.[61] This is the time allocated to warn people of the accident and inform them that an evacuation may be eminent, and that they should evacuate if an order to evacuate is given. The time allocated for warning diffusion varies based on the system in place to disseminate the warning as is clear in Figure 5-9.[62] While a 15 minute approximation for the time to alert and notify the population surrounding Millstone might be appropriate for the majority (90%) of the population, by looking at the siren and telephone curve[63], it is clear that there still exists a portion of the population that can take substantially longer to respond (in that case, the last 10% of the population takes an additional 65 minutes to respond).

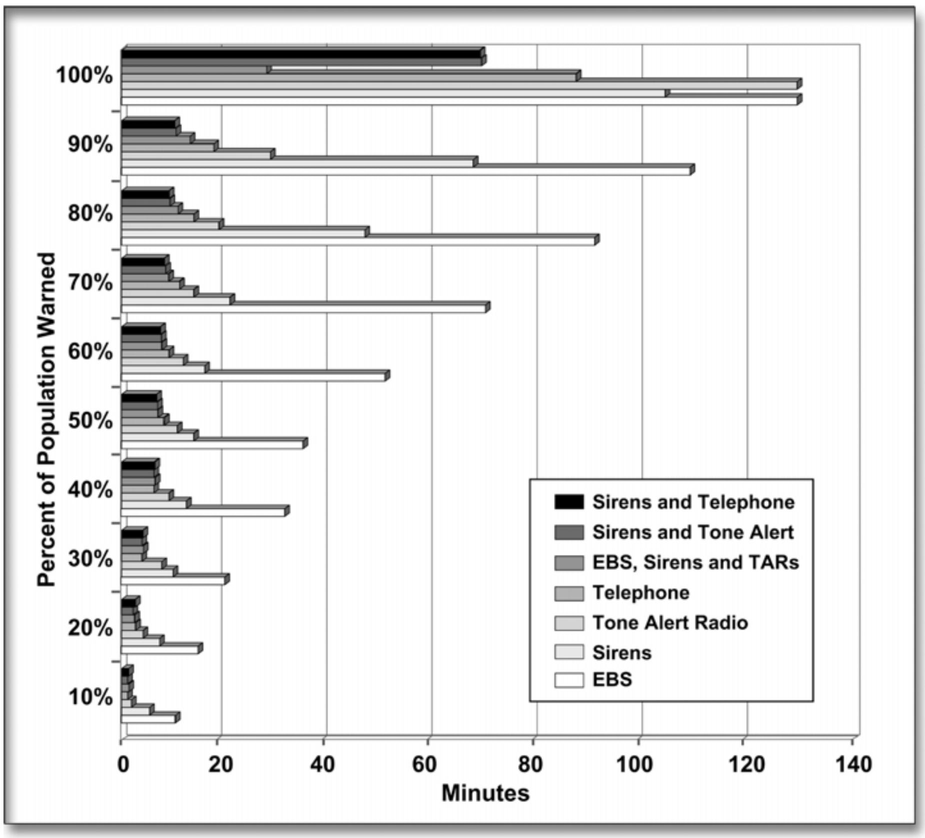

Figure 5-9: Warning Diffusion Curves For Different Warning Systems

Earth Tech used public mobilization times that have been developed for each population component (i.e., permanent residents, seasonal residents, transients and special facilities). These times were developed in consultation with state emergency preparedness officials. The methodology of how the mobilization times were established is not included in the report. The study assumes that after the initial 15-minute time period, all populations except for the

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[61] The system used for the area surrounding the Millstone plant uses these three types of alert and notification – although the route alerting is used only as a backup system to ensure compliance, not as a primary system.

[62] Evaluating Protective Actions for Chemical Agent Emergencies (Rogers, G. O., et al., Evaluating protective Actions for Chemical Emergencies (ORNL-6615) Oak Ridge, TN: Oak Ridge National Laboratory.

[63]The Siren & Telephone curve represents something similar to Sirens and EAS/EBS as they represent an indoor and outdoor A&N system.

residential are loaded at a linear rate over a specific time interval. While this is a common assumption for Earth Tech studies,[64] it may not be appropriate based on actual response characteristics. Once again, this area requires justification for the use of specific public mobilization times. Having concurrence from emergency management officials is necessary, but not necessarily sufficient for generating valid evacuation time estimates. The loading distribution curves are presented in Figure 5-10 below.

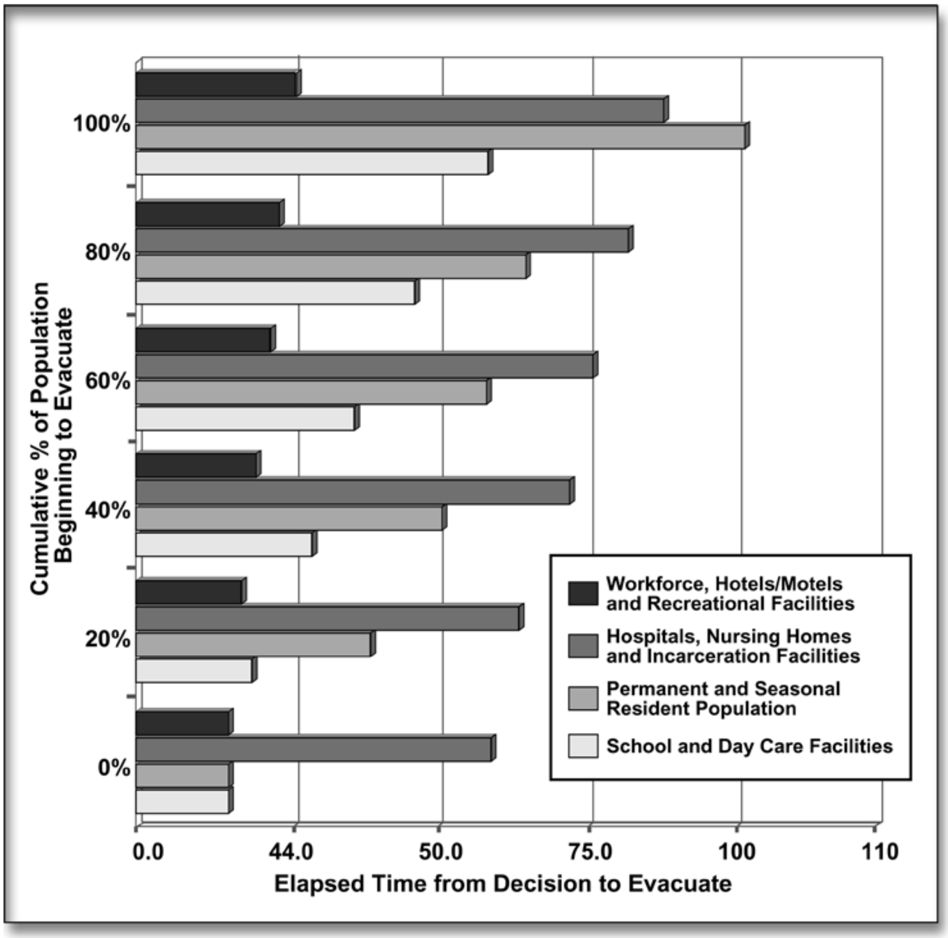

Figure 5-10: Notification/Preparation/Mobilization Time Distributions (Earth Tech's 1997 Study)

IEM compared the "permanent and seasonal residential population" curve to those in Figure 5-11, and it appears that they are comparable (although it should be pointed out the curves in Figure 5-11 are based on a general population, to include special populations, schools, etc.). Figure 5-11 shows curves that were derived from data presented in *Evaluating protective Actions for Chemical Emergencies.*[65] The Oak Ridge National Laboratory data was collected during

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[64] Similar assumptions have recently been used by Earth Tech for ETEs across the country including the Perry plant (Ohio), the McGuire, Oconee, and Catawba plants (North and South Carolina), the Maine Yankee plant and the Limerick plant (Pennsylvania)
[65] Rogers, G. O., et al., (ORNL-6615) Oak Ridge, TN: Oak Ridge National Laboratory.

evacuations executed in response to three large-scale chemical spills ranging in size from approximately 1,000 (Confluence) to over 250,000 (Mississauga) people. This data explicitly incorporates the time required for individuals to respond to a warning and prepare to evacuate. The data collected for each evacuation was based on a combination of three population types—transient, permanent, and special population—and is appropriate to use as general mobilization curves an entire population, but not a specific one. This data should only be used as a general point of reference to better understand the comparison being done here.

Some particular issues come up from the special types of populations that are being evaluated separately. For example, Figure 5-10 indicates that it will take 60 minutes for 100% of school and daycare facilities to begin evacuation after receiving the warning and notification. It was not stated in the report if this was a single wave or multi-wave evacuation from the schools or if the schools had buses on campus or if the buses had to be brought in from somewhere else. Such detailed information is needed to determine if the data is valid for a given scenario. Generally a 60-minute evacuation time for schools and daycares may be considered high, unless it is taking into consideration the time it might take buses to be driven in from an off-site parking area. These assumptions, while necessary to be coordinated with State emergency preparedness officials, should be based on realistic data from drills or similar incidents that required evacuations, when possible.

The rationale explaining why an assumption of linear loading rates over specific time periods was used was not included in the report. This assumption may not be valid depending on how large the time periods are. The longer the time period, the more important the assumption of a linear behavior becomes. The loading rates from several evacuation studies indicate that the loading rate on the evacuation network during an evacuation is not linear over specific time periods. The curves in Figure 5-11, show that the loading rates are not linear but steep during the onset of the evacuation and then level off at about the time when 90% of the population is on the network. Since the time periods are not long, this assumption might have minimal impact on the validity of the evacuation time estimate.

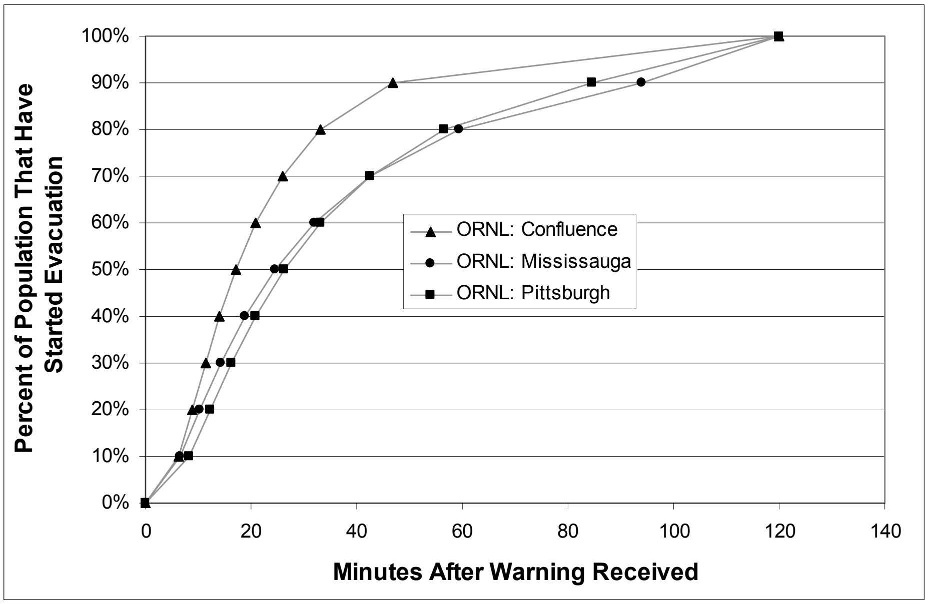

Figure 5-11: Probability of Response after Receipt of Emergency Warnings in Three Chemical Accidents

Shadow Evacuation

Only evacuation within the ten-mile emergency planning zone was considered in this analysis. The possibility of shadow evacuation in Connecticut was not considered in the Earth Tech study. In this study, all the calculations of evacuation times, road capacities, and other logistical concerns assume no additional usage or loads by those outside the emergency planning zone who may decide to evacuate without either instruction from authorities to do so.

Research on shadow evacuation by experts indicate that some shadow evacuation will occur, and that it should be factored into emergency planning (refer to Section 5.2.3 for information on shadow evacuation experts). IEM recommends that shadow evacuation should be considered in an updated study for Millstone. While it may seem that Millstone may not have as extensive an issue with shadow evacuation as Indian Point because of evacuation data resulting from the number of times storms have threatened serious damage, it is speculative to say that the type of person who might decide to wait-out a threatening hurricane would choose to ignore a nuclear event.

Preliminary studies and/or surveys should be conducted to determine how much and how far beyond the ten-mile emergency planning zone shadow evacuation in Connecticut will occur. With shadow evacuation incorporated into the updated evacuation time estimates, emergency managers will be in a much better position to make decisions and allocate resources during an evacuation.

5.2.5.3 Evacuation Time Estimates for Emergency Planning Zones in New York State

Evacuation time estimates for winter weekday, winter weeknight, and summer weekend for fair and adverse weather conditions were estimated in the study. These estimates represent the total time for the total vehicles within the respective areas to evacuate. The estimates include the time required for evacuation notification, preparation and mobilization activities, plus travel time out of the emergency planning zone. The areas of interest in this review are Fishers Island and Plum Island.

Fishers Island

Fishers Island is located partially within the ten-mile planning zone, at 7.5 to 10 miles from the facility. This study indicates that the estimated population for winter weekday, winter weeknight, and summer weekend are 418, 329, and 2,554, respectively.

IEM generated an approximation for the summer weekend population using U.S. Census 2000 data and obtained a figure of around 4,175 people. The difference in the peak populations for Fishers Island is significant. The population figures used in this study may not be valid presently and need to be updated.

The evacuation of Fishers Island will take place by ferry to New London or Stonington in accordance with the current radiological emergency response procedures. From either location transportation assistance will be coordinated with state and local emergency preparedness officials.

A transportation or coordination plan with State and local emergency preparedness officials was not included in the report. Transportation and coordination issues such as single wave or multi-wave evacuations, number of buses, number of bus drivers, municipalities and/or counties that will be providing these resources, memorandums of understanding and coordination between the various agencies should be explicitly stated in the report as justification for the assumptions that are made.

In the report, only the evacuation procedure via New London is stated explicitly with the following evacuation route—ferry to New London, US Route 1; CT Route 85; Interstate Route 95, CT Route 32 to Windham High School.

It was also estimated in the report that it would require approximately 255 minutes or 4.25 hours to evacuate Fishers Island during a winter weekday or a winter weeknight. This evacuation allows for 1 hour notification, preparation, mobilization time, 1.5 hours for the ferry to travel round trip to and from the island, 1 hour to load and unload passengers, and 1 hour to bus evacuees out of the emergency planning zone. During a typical summer weekend, this evacuation time would be expected to increase by 2.5 hours to allow for a second ferry trip, which would be necessary in order to accommodate the high seasonal population of the island. This is a significant point because it relates to the issue of using current population data. If the population increased significantly, this could cause one or more additional ferry trips. While the winter time of 4.25 hours would have no impact on the total emergency population zone evacuation times, the summer time of 6.75 hours is almost the same as the emergency population zone evacuation time of 6.8 hours. Therefore, if even one additional ferry trip were necessary, this could significantly impact the overall emergency population zone evacuation time.

More explicitly, from this study, the summer weekend population at Fishers Island is approximately 6 times that of a winter weekday. With the assumption stated above of using only one ferry in the evacuation, a ferry capacity of approximately 900 evacuees per trip (the ferries now in service vary in their capacities), and a current summer weekend population of approximately 4000 people, around 4 ferry trips will be required. Using the time estimates from this study, each additional ferry trip increases the evacuation time estimates by 2.5 hours. The total time that will then be required to evacuate Fishers Island on a summer weekend is 11.75 hours. The evacuation time for the Millstone emergency planning zone is 6.8 hours. Use of additional resources would most likely yield shorter evacuation times, and use of more than one ferry would reduce the number of ferry trips necessary. The use of additional public or private marine transportation would further reduce the evacuation times. But the implications of an extended evacuation time need consideration.

In the report it is stated that the use of a destination outside the emergency planning zone, such as Stonington, would serve to reduce the evacuation time as opposed to using New London. However, no details on this option involving the evacuation time estimates or specific bus routes to the reception center from Stonington was provided in the report. This may actually be a safer option, as the evacuees will be ferried to a destination outside the emergency planning zone and away from the nuclear plant. Another benefit could be a reduction of the amount of traffic within the emergency planning zone network resulting in shorter overall evacuation time estimates. It is a telling point that in discussions with both Fishers Island authorities and ferry authorities, evacuation to Stonington was assumed.

Besides the clear need for the population updates, we recommend that this option of using Stonington in evacuating Fishers Island be more clearly developed. Detailed analyses to determine the evacuation time estimates, the specific routes for the buses to the reception centers, and the impacts on the emergency planning zone evacuation time estimates should be conducted.

Plum Island

Plum Island is located approximately 8 miles south of the Millstone Plant and is the site of a Department of Agriculture facility. Population for Plum Island is 256 on a typical winter weekday, and 5 for both winter weeknight and summer weekend.

Plum Island is accessible via ferry to Orient Point located within the town of Southold, New York, on Long Island. According to the radiological emergency response procedures, this area could be evacuated within 45 minutes by utilizing the ferries. Even accounting for the required notification, preparation, and mobilization, the evacuation time for Plum Island is significantly shorter than that of the entire emergency planning zone, and would be expected to have no impact on any other evacuation times.

There is no indication in the report as to what will happen to the evacuees when they get to Orient Point. It may be correctly assumed that they will use personal transportation and would not need a reception center, but that should be made clear. Also no coordination with the town of

Southold is included in the report. Southold's role in the event of an evacuation should be stated explicitly in the report to justify the assumptions that are made in the analysis done by Earth Tech.

The issue of shadow evacuation may have an impact here. The residents of Southold and other neighboring towns may decide to evacuate. There are no plans available presently to handle such a situation. Therefore shadow evacuation for this area should be included and planned for in the next updated study for Millstone.

5.2.5.4 Observations Concerning Evacuation Time Estimates Review

Earth Tech's NETVAC model is a valid and acceptable model in establishing evacuation time estimates for nuclear plants. It has been used by Earth Tech at over 40 nuclear sites, and in states for coastal flooding scenarios. The current version of the software is called NETVAC 2, and has been successfully reviewed at Atomic Safety and Licensing Board hearings.

The study being reviewed (most recently updated evacuation time estimates study) for the Millstone Plant was conducted in 1997. Most of the data used in the study were obtained in 1990 (U.S. Census data) and in 1992 (telephone surveys for other demographic data, and evacuation network survey data). Presently, the demographics of this area and the roadway network are likely very different from the data used to represent its current status. With the availability of 2000 census data, NUREG-0654 requires that the evacuation time estimates for every nuclear plant within the nation be updated once new demographic and or any other data used in establishing the evacuation time estimates become available. The evacuation time estimates study for Millstone should be updated using current demographic data of this area as well as using updated evacuation network data, and assumptions regarding the manner and destination of the evacuations from the island. This is a critical step that must be done to provide emergency managers the information they need to make well-informed decisions with respect to the plausibility of an evacuation in the event of a nuclear accident.

In summary, IEM established the following issues as being potentially problematic for the accurate generation of meaningful evacuation time estimates:

- The time used for warning to diffuse throughout a population was not justified and seems to be not consistent with accepted diffusion rates. The use of a 15 minute notification time does not represent the slowest 10% of the population very well and could be artificially reducing the overall evacuation time estimates.
- The school populations take up to an hour to load the network. While this may be a valid assumption, there is no documentation on why.
- Shadow evacuations were not addressed in this study. This could have an impact on the ability of the island inhabitants to get to their reception centers and should be evaluated.
- Transportation and coordination planning with State and local emergency officials was not included in this report. It is essential that such plans be included or referenced in the report to validate assumptions about coordinated responses. This is very necessary for evacuating both islands, as they use different modes of transportation at various times in the evacuation process. The emergency managers should be confident that the evacuation time estimates were generated using the correct assumptions regarding coordinated efforts between agencies

IEM's most significant finding was related to the age of the data being used for the evacuation time estimates. Significant population changes over the past 10 years should be reflected in the evacuation study. In the instance of a summer weekend night, the population difference was projected to be approximately 1,500 people, which could generate an evacuation time estimate 5 hours longer than currently projected. If this estimate were correct, this would change the ten-mile emergency planning zone evacuation time estimate from 6.8 hours to 11.75 hours. Less conservative evacuation assumptions (e.g., no ferry is inoperable so more than one ferry would be available to evacuate people off Fishers Island) would also have a significant impact.

5.3 Alert and Notification System Review

The alert and notification system is a critical component of the emergency response system. Radiation is an invisible hazard and for most accidents that could potentially occur at Indian Point, there would be few environmental cues that an accident has occurred. People living, working, and transiting through the area would not know that they need to discontinue their normal lives and take protective action. The alert and notification system provides the initial alert that something out of the ordinary has occurred. The notification part of this system then gives them information on what has occurred or may occur, who is at risk or potentially at risk and what protective actions are recommended.

5.3.1 Review of Indian Point Alert and Notification System

The alert system at Indian Point consists mainly of sirens that are designed to be activated in an emergency. In addition, tone alert radios are to be used in population centers around Indian Point which fall under the Low Siren Coverage Area. That is, tone alert radios are deemed necessary for those population centers that do not pass the FEMA Alert and Notification Criteria. Route alerting, a practice in which emergency personnel drive around neighborhoods alerting residents, is also practiced. Finally, notification is expected to occur through the Emergency Alert System. County agencies are responsible for route alerting and activation of the Emergency Alert System.

IEM reviewed Indian Point's alert and notification system to independently verify that within the ten-mile emergency planning zone, the system meets the FEMA *Alerting Criteria for Alert and Notification*. As part of the review, IEM evaluated sound level contours generated from the most recent sound propagation study. The model used in the study includes the effects of topography, vegetation, and meteorology around the Indian Point facility.

5.3.1.1 Independent Review Methodology for Evaluation of Indian Point Alert and Notification System

IEM's independent review of Indian Point's alert and notification system is based on:

- "Alert & Notification System—Indian Point Nuclear Power Plant," prepared by New York Power Authority and Consolidated Edison Company of New York, August 1984;
- "Wyle Research Report—Alert System Design for Indian Point Nuclear Power Plants, July 1984;" and the "Wyle Research Report—Alert System Design for Indian Point Nuclear Power Plants—Appendix C, July 1984."

The first two documents discuss the details of the types of sirens used, the plans and procedures that have been designed to best alert the areas surrounding Indian Point in the event of an accident, and the most recent sound propagation study for Indian Point. The last document is a compilation of the results from the sound propagation model and consists of figures showing sound contours for all the sirens around Indian Point.[66]

IEM began the review by studying the demographics, geography and meteorology of Indian Point. The demographics of the region surrounding the nuclear power plant play a major role in the design of an effective alert and notification system, since demographics determine the level of ambient noise[67] that exists in any population center: the larger the population density in any area, the higher the ambient noise level. For sirens to be heard in such areas, the minimum sound level that must be generated by the sirens should be higher than in areas where the ambient noise level is lower. Similarly, geographic features of the area such as forested regions, water bodies, and hilly terrain are extremely important factors influencing the sound-level intensity. For instance, population groups that are located in extremely hilly terrain may not be able to hear the siren because the hills and mountains intercept the sound waves and reduce their intensity. As will be discussed in more detail later, meteorological conditions such as wind speed, wind direction, and temperature gradients also have a significant effect on sound intensity levels.

IEM evaluated the sound propagation model by studying the various assumptions that were made in the model. The actual method used to calculate sound levels was also evaluated by comparing the theory with available state-of-the-art models for sound propagation. The main focus of IEM's evaluation constituted studying the predicted sound contour levels. A contour level is a collection of locations that receive the same sound intensity. For instance, the predicted sound level contours for Indian Point in the appendix of the alert and notification design document consist of the collection of locations that receive 60dB through 70dB sound-intensity levels in steps of 5dB. Computer simulation is used to decide how many sirens are needed for a certain county and where they need to be located. The computer simulation program consists of a sound propagation model that uses fundamental acoustic equations to predict the path of sound waves and their attenuation because of various environmental factors. This sound propagation model needs to be sufficiently accurate (or at least conservative[68]) in its predictions of sound-level intensity so that the results can be used to set up an effective siren system.

After the evaluation of the sound propagation model, IEM compared the field data of observed sound levels with FEMA's minimum requirements. Based on ambient noise and other demographic data, FEMA has developed standards and requirements that alert and notification systems must meet. For instance, standards require that within the ten-mile emergency planning zone, areas with certain population density must be alerted using a minimum sound level in order to ensure that the warning siren tones are audible to the entire population. After the siren system

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[66] The alert and notification analysis conducted by IEM was constrained in scope. IEM did not perform model runs using any sound propagation model to check results presented in the document. As a result, IEM can only provide an overall review of the model used by Wyle Research to produce the sound contours.
[67] Ambient noise signifies the background noise that exists in any population center. For instance, the ambient noise in a center that is located near an airport is much larger as compared to a center that is located in a rural area
[68] A conservative sound propagation model is one which predicts sound level intensity that are lesser in value than the actual sound levels that would be observed.

is put in place, field data is collected to determine the actual sound levels produced by the sirens in a test scenario. An effective alert and notification system is one that satisfies these minimum standards for all population centers.

5.3.2 Alert and Notification Review Findings for Indian Point

This review includes FEMA alerting criteria, ten-mile emergency planning zone demography, geography, and meteorology around Indian Point; and review of the Indian Point Alert and Notification Plan. The Indian Point Alert and Notification Plan review includes alert devices, emergency alert systems, backup alternative systems, and the sound propagation model (sound contours).

5.3.2.1 Emergency Planning Zone Demography, Geography, and Meteorology

The FEMA alerting criteria are population-density dependent. For areas that have a population density of more than 2000 people per square mile, sound levels should be at least 70 decibels. For areas that have a population density of less than 2000 people per square mile, sound levels should be at least 60 dB.

The area surrounding Indian Point is divided according to the following demographic features:

- Areas with population densities above 2000 people per square mile—Includes areas in the northwest region of Westchester County, encompassing the following population centers: Peekskill, Ossining, Cortlandt, Yorktown, Croton-on-Hudson, and Lake Mohegan.
- Areas with population densities below 2000 people per square mile—Includes the population of Lake Peekskill in Putnam County, Stony Point and Haverstraw in Rockland County, and Highland Falls and Fort Montgomery in Orange County.
- Rural areas with sparse population densities—Includes the remaining area within the ten-mile Indian Point ten-mile emergency planning zone.
- Park lands and military facilities—Includes the Palisades Interstate Park System and the U.S. Military Academy at West Point. These facilities are located mainly on the west side of the Hudson River in Rockland and Orange Counties.

In the geographical area around Indian Point, the elevation range is from 50 feet to a maximum of 1000 feet above mean sea level. The topography could be broadly categorized into the western area and eastern areas. The western area is characterized by steep and heavily wooded terrain, including the Dunderberg and West Mountains and the Buckberg Mountain. The eastern area has generally much lower peaks and ridges, including the Spitzenberg and Blue Mountains. The Hudson River runs through the approximate middle of the plume emergency planning zone in the north-south direction. The meteorological conditions around the Indian Point area are given in Tables 1–3 of Appendix F.[69]

[69] "Final Environmental Statement Related to Selection of the Preferred Closed Cycle Cooling System at Indian Point #3." December 1979. Pages 1-12.

5.3.2.2 Review of Indian Point Alert and Notification Plan

The Indian Point alert and notification system originally consisted of 151 sirens located throughout the ten-mile emergency planning zone. Three additional sirens were added after the March 1982 Siren System Test. All but one of the sirens is the high-powered, rotating type manufactured by the Alerting Communicators of America (alternating current) Model Penetrator-10.[70] The remaining siren, a Whelen Type WS-2000 electronic siren (#247), has been installed in Rockland County as a requirement for the special notification needs of the local community. The sirens in each county are controlled by the respective county authorities.

In addition, a route-alerting system is installed at Indian Point as a backup alternative service in case any siren system stops working. In case of a siren system malfunction, each county's Emergency Operations Center director has a process in place to alert either the county's sheriff or the local police department to activate route alerting. County plans indicate that route alerting will require 15 to 45 minutes to implement during an event.

5.3.2.3 Discussion of Sound Contour Levels

Wyle Laboratories has published siren level contour results from the sound propagation model for the area around Indian Point as an appendix to the report. This appendix consists of four sound intensity contours that range from 75 dB to 60 dB in steps of 5 dB for each of the 151 single- or dual-tone sirens installed in that area. The sirens cover an area of four counties: Westchester (77 sirens), Putnam (10 sirens), Orange (16 sirens), and Rockland County (51 sirens). The contours have been used by Indian Point to decide on the location of each siren in the counties.

In addition, a full-length paper copy of a map of the field data collected for siren-level contours for 60 dB and 70 dB sound levels were provided to IEM. The comments below are based on the map-study of this field data.

Westchester County consists of population centers that are some of the most densely populated in the area around Indian Point. Based on the model results, it appears that almost all of the Westchester County area is within the 70dB sound level range, and as such, satisfies the requirement of the Alert and Notification Plan. In fact, on the western side of Westchester County, the 70dB contours extend well into the Hudson River because 77 sirens have been placed in the county, thereby ensuring good coverage in the populated areas.

Lake Peekskill is the only population in Putnam County with a population approaching 2000 individuals per square mile. The contour map shows it as a 70dB contour. In Putnam County, the 70dB contours do not extend as far out as they do in Westchester County. The ten-mile radius is intersected largely by the 60dB contours that cover most population centers with small

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[70] There are two types of sirens that look physically similar. One type is powered by a 10 HP electric motor and produces a continuous dual tone sound with fundamental frequencies of 510 Hz and 680 Hz. The other type is powered by a 15 HP electric motor and produces a continuous single-tone sound at a fundamental frequency of 453Hz. The rotational speed of both types of sirens is about 3-4 revolutions per minute. The sound output of the dual tone sirens is 119 dB measured at a distance of 100 feet from the siren along its centerline. The sound output of the single-tone sirens, on the other hand, is 115 dB at a distance of 100 feet from the siren along its centerline.

populations. Since Putnam County does not have as many densely populated population centers as Westchester County and also since its area within the ten-mile emergency planning zone is relatively small, fewer sirens are installed there.

Highland Falls and Fort Montgomery are the two population centers in Orange County with sizeable populations. Fort Montgomery lies within 5-mile radius around Indian Point, while Highland Falls lies within the ten-mile radius. It can be seen from the contour maps that both population centers are covered under the 70dB siren-level contour. This is favorable, since even as the population in these population centers grows beyond 2000, they should still satisfy the FEMA alert and notification requirement.

Rockland County consists of two main population centers of Haverstraw and Stony Point, both with populations of less than 2000. Both population centers lie in the 5-mile radius of Indian Point and within the 70dB siren-level contour.

Therefore, it appears that there is adequate siren coverage in the Indian Point area. However, it is still feasible to have localized places where sound does not travel well. Actual field siren tests determine these areas.

Also, based on review of the sound propagation model, IEM makes the following suggestions to better estimate the sound-level contours:

- The model used to generate the sound contours is simplistic. While it does attempt to take into account the various effects the environment has on the attenuation of a sound wave, most of the physics is included in a simplistic fashion. In particular, the handling of the effects of hilly terrain, temperature, and wind-speed gradients is likely to be over-conservative (i.e., it understates the range of the sirens).
- Several assumptions and approximations were made to make the model runs more efficient to fit the computing power and resources of the times; however, between the time of the publication of these sound-level contours and the present, major advances have been made in the computational techniques that exploit the speed and efficiency of modern computers. The advent of faster and more efficient machines has, to a large extent, allowed the use of more complex and more accurate acoustic models that take into account all of the above effects in a more consistent and fundamental fashion.
- IEM previously stated that the siren sound propagation study that was originally done to support placement of alert devices around Indian Point appeared adequate using the technology available at the time. Significant differences between the original results and an updated sound propagation study using more modern computer code are unlikely, but this can only be confirmed with data from an updated study. Since the state of the art for such studies has matured and newer computer modeling codes can accommodate more of the physics involved in propagation of the alert signal (better handling of atmospheric attenuation of the sound based on different weather conditions for example), IEM recommends that new sound-level contours for the Indian Point site be run using any one of the modern acoustic wave propagation programs that are available either commercially or through free download from the Web sites of some of the US government laboratories. There are several types of acoustic models to choose from, and they vary in their degree of sophistication based on the kind of approximations and assumptions made. Of the

> three principal methods popularly used in sound propagation modeling—the Normal Modes method, the parabolic equation method and the ray-tracing method—it is IEM's belief that the programs that employ the ray-tracing method are best-suited for the needs of siren contouring, since the ray-tracing method combines speed, efficiency, and accuracy at an optimal level.

Overall, IEM reviewers concluded, based on the siren contour field data results, that the siren coverage requirements of FEMA are indeed being satisfactorily met by the Alert and Notification Plan at Indian Point.

The Nuclear Regulatory Commission also requires the Indian Point facility to report on the alert and notification system. These self-reports are part of the Nuclear Regulatory Commission performance indicator program. The section below contains information submitted to the Nuclear Regulatory Commission by the Indian Point plant on the alert and notification system currently in place.

5.3.2.4 Alert and Notification System Reliability: Nuclear Regulatory Commission Data

According to the Nuclear Regulatory Commission Inspection Manual, the alert and notification system has been identified as "the most risk-significant equipment system maintained by nuclear plant emergency preparedness programs" because it is a crucial link for alerting and notifying the public of the need to take protective actions. The Nuclear Regulatory Commission deems the alert and notification system as one of only three important pieces of the emergency preparedness system at the facility.

The Nuclear Regulatory Commission requires plant owners to conduct periodic tests of the siren systems at each site. Results of these tests are sent back to the Nuclear Regulatory Commission to be incorporated into performance indicators on alert and notification system reliability. The utility is required to show the percentage of sirens on the Indian Point site capable of performing their function in periodic siren testing. The intent is to measure availability of the sirens to broadcast warning messages during an emergency.
The indicator is calculated every 12 months by dividing the total number of alert and notification system siren tests by the number of successful alert and notification system siren tests. In general, Nuclear Regulatory Commission requires the following (as per NUREG-0654, Appendix 3):[71]

- Silent Test: every two weeks
- Growl Test: Quarterly and after maintenance is performed
- Complete Cycle Test: at least annually

The Nuclear Regulatory Commission requires that 90% of siren tests are successful, and a success rate of 94% is considered as exceeding the requirement. A 90% or above score is rated "GREEN" by Nuclear Regulatory Commission. Less than 90% is rated WHITE, triggering

[71] FEMA may approve deviations from this schedule.

increased and mandatory regulatory oversight. Nuclear Regulatory Commission also looks for the reliability of each siren. It is, for example, not acceptable for the overall system reliability to be above 94% but for individual sirens to fail consistently.

Figure 5-12 below shows alert and notification system performance thresholds for Indian Point 2 and Indian Point 3 from the first quarter of 1999 to the second quarter of 2002 As shown in the figure below, the alert and notification system reliability measurements for both reactors are relatively consistent from 1999 to 2002. The percentage of successful alert and notification system siren tests has stayed above 98%.

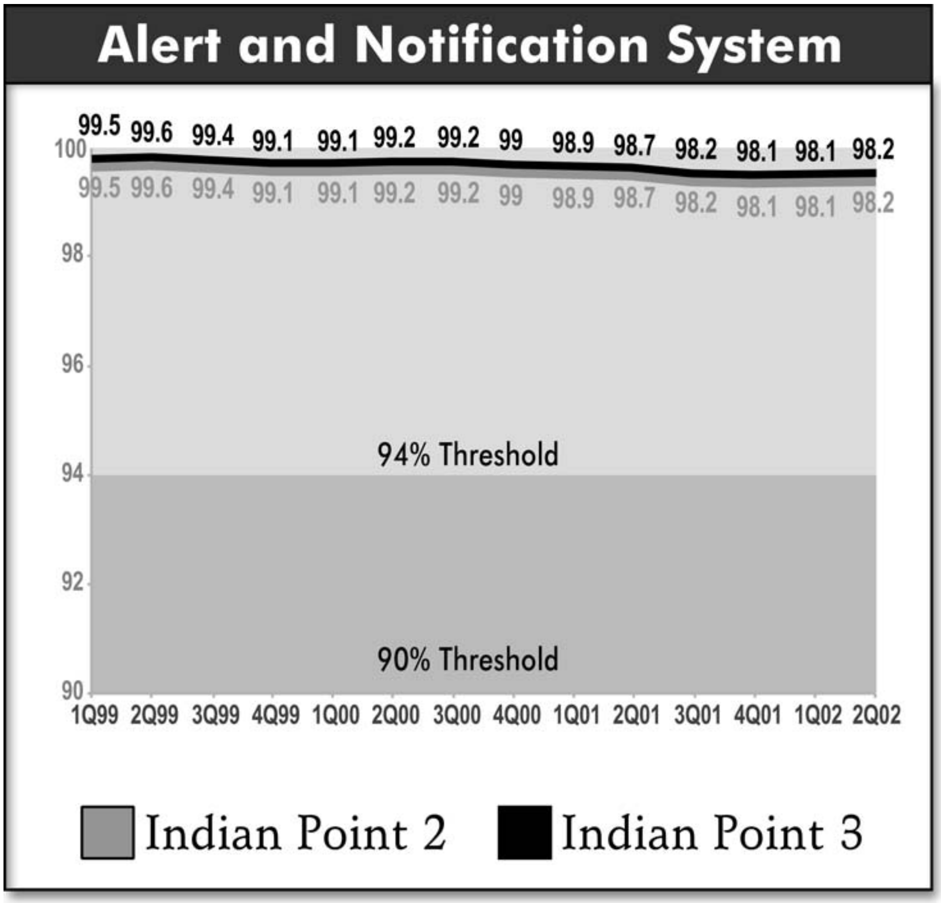

Figure 5-12: Alert and Notification System Performance Thresholds for Indian Point

Figure 5-13 below shows alert and notification system performance thresholds for Millstone 2 and Millstone 3 from the first quarter of 1999 to the second quarter of 2002. As shown in the figure below, the alert and notification system reliability measurements for both reactors are the same for the documented period. As with Indian Point alert and notification thresholds, the percentage of successful alert and notification system siren tests has stayed above 98%.

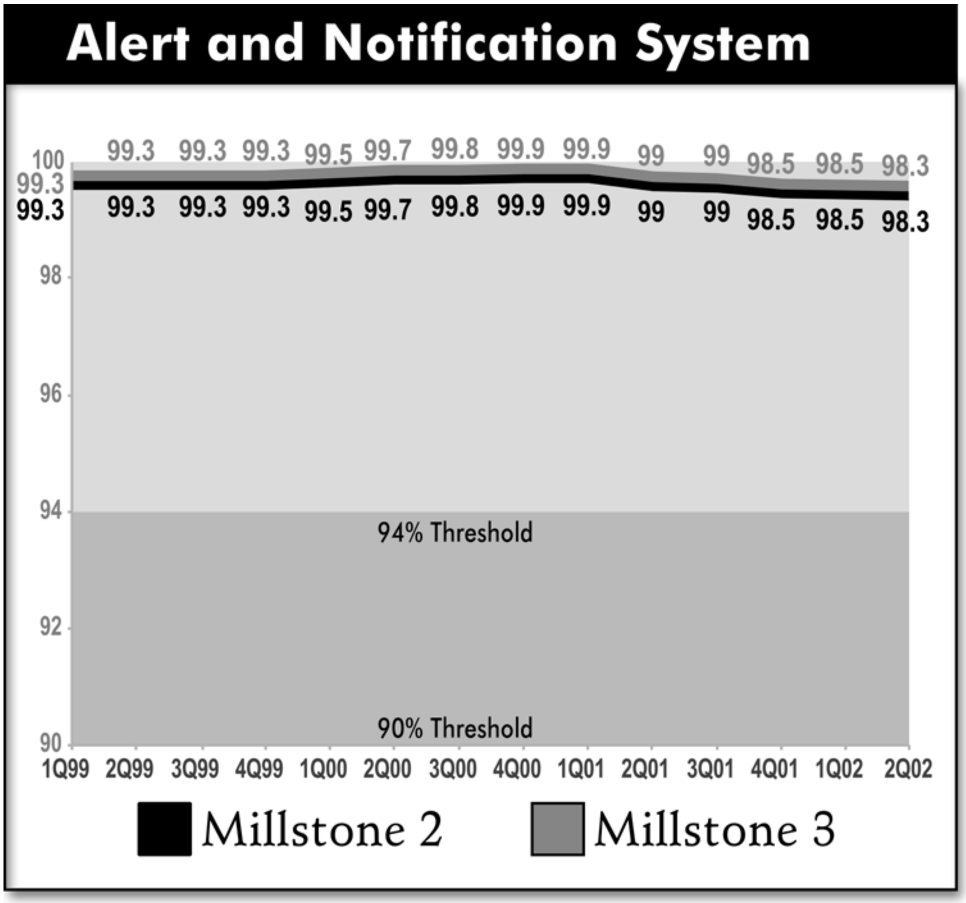

Figure 5-13: Alert and Notification System Performance Thresholds for Millstone

5.3.2.5 Providing Timely, Accurate, and Meaningful Public Warning: A Performance Outcome Analysis

Public alert and notification is sent out using sirens, tone alert radios, Emergency Alert System and route alerting (as a back-up or augmenting method). The equipment to alert and notify people is only a part of the overall emergency warning process. A much larger, more complex, and more time-consuming part of the process is the manner in which the public actually gets warned. Warning diffusion is the rate at which the public becomes aware of the information being disseminated from the emergency management authority. People are not warned as soon as the alert and notification equipment sounds and provides messages. Some people hear the blare of the sirens and tone alert radios and tune into their Emergency Alert System to hear messages and understand what is being conveyed. Many others hear the sirens and tone alert radios and seek confirmation from neighbors, friends or authorities (hence the need for a hot line, as recommended elsewhere). Others do not hear or do not pay heed to the sirens, tone alert radios, and route alerting. We recommend that the existing reverse telephone calling systems in use at Indian Point be used in coordination with the existing public alert and notification systems for Indian Point to increase the speed, credibility and understandability of the warning associated with a radiological emergency. The use of the systems for this purpose should be practiced live and documented, as with Rockland County's use of the system in association with 2002 siren upgrades. The same recommendation applies for existing or planned systems at Millstone. Reverse telephone calling systems are community alerting mechanisms that rapidly places phone calls with a prerecorded message containing important alert information to particular geographic areas within counties.

Disaster researchers have examined this diffusion of public warning through the populace. They have collected information on how this warning diffuses through the population in response to alert and notifications during evacuations executed in response to large-scale chemical spills. The rate at which the public receives warning and takes action is derived from data presented in *Evaluating Protective Actions for Chemical Agent Emergencies*.[72] Figure 5-14 below shows the warning diffusion in time. A key point is that warning propagates through the public at a predictable rate based on the type of alert and notification systems in place. It is very important to note that if tone alert radios were incorporated, the warning diffusion time could be reduced by approximately 50%. Another is that combining many different alert and notification methods can dramatically speed up warning diffusion. The curve below incorporates data on the diffusion of warning to transient, permanent, and special populations and is therefore appropriate to use as "general" warning diffusion curves for all three population types.[73]

[72] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615), Oak Ridge, TN: Oak Ridge National Laboratory, 1990.
[73] The rates derived in this study are taken from chemical (HAZMAT) incidents. IEM acknowledges that there could be differences between a population at risk from a chemical accident and the populations surrounding a nuclear energy facility. However, the Rogers, et al., data represents the best empirically derived and peer reviewed public response information associated with evacuations.

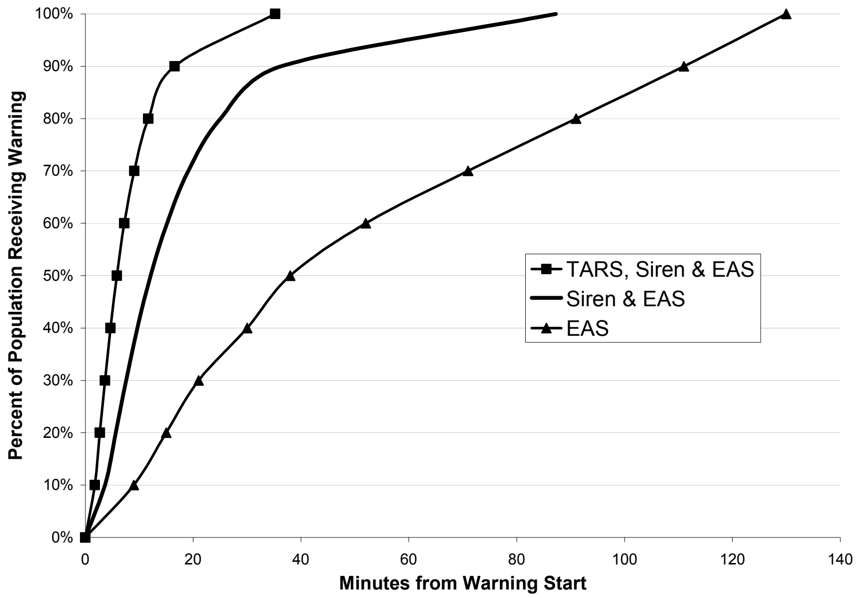

Figure 5-14: Warning Diffusion for a Combination of Selected Notification Systems[74]

Once the public is warned, they still do not take action immediately. Most people go through a decision process that involves thinking and deciding what their next actions are. The majority of the public will not start following instructions that are provided by an alert and notification system immediately – they will do several common things such as closing up their houses/offices or confirming that the protective action is warranted by perhaps calling a neighbor or a family member. *Public mobilization* ("mobilization") is the rate at which the public completes the decision process to act according to instructions provided through the warning process. Disaster researchers have also noted the time that this process takes and have provided heuristics on how long this takes. This *mobilization* curve, Figure 5-15, shows the rate at which the public begins to take protective action once they have received and understood the warning.

[74]Rogers, page 25.

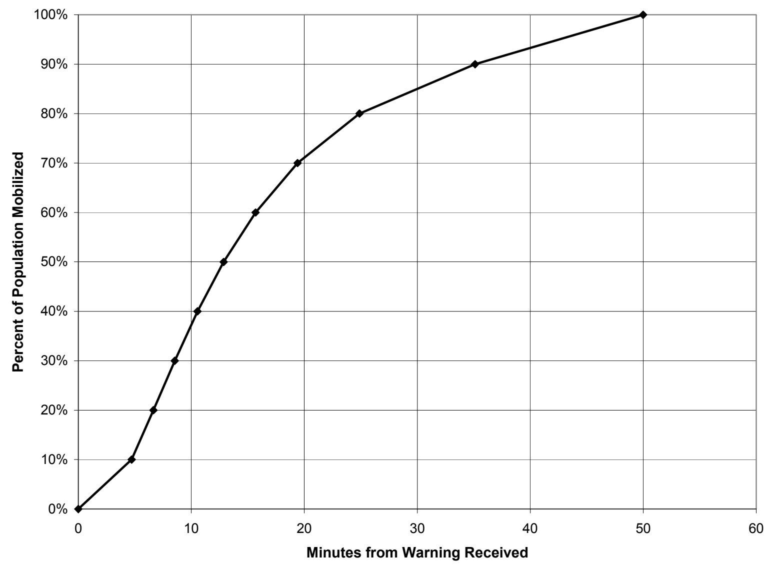

Figure 5-15: Population Mobilization Times[75]

Public education is one of the key items that can impact how fast and effectively people mobilize. The dilemma of public education is that since people are generally busy with their own lives, it is difficult to send messages on emergencies and have them be received and incorporated. Disaster research into mobilization and public education for other hazards has indicated that there are two actions that can assist in impacting the public's ability to mobilize faster during an emergency:[76]

- The form, content, frequency and legitimacy of the person delivering the warning message at the time of an emergency
- Family preparedness plans developed prior to a disaster

In addition to public education efforts that can enhance the public's ability to mobilize during an emergency, business information technology systems can be integrated with alert and notification systems so that individuals receive information about an emergency in a speedy and more effective fashion. Notifications can immediately be sent to all terminals linked into a system.

The public needs to be warned in time, with accurate information on what is happening and how it can protect itself, and the information has to be understandable to the public. If the desire is to evacuate people before the hazard arrives near the people, it is necessary to initiate the alert and notification systems in time to allow the warning to diffuse and the mobilization to occur for a significant proportion of the population. Refer to Chapter 9 for a discussion of this issue with a

[75] Rogers, 25.
[76] Beriwal, Madhu. *Strategic Public Education Plan for Anniston Site*. Innovative Emergency Management, December 1998. IEM/TEC98-038.

performance analysis of the observations gathered from the September 24, 2002 full-scale exercise.

The scope of work under the evacuation time estimate study includes a survey of the population to gauge the level of public education required. This survey may show some of the Indian Point unique aspects of public education and mobilization.

The public needs to be warned in time, with accurate information on what is happening and how they can protect themselves, and the information has to be understandable to them. If the desire is to evacuate people before the hazard arrives near the people, it is necessary to initiate the alert and notification systems in time to allow the warning to diffuse and the mobilization to occur for a significant proportion of the population. Refer to Chapter 9 for a discussion of this issue with a performance analysis of the observations gathered from the September 24, 2002 full-scale exercise.

5.3.3 Review of Millstone Alert and Notification System

The alert and notification system at Millstone is a critical component of the facility's emergency response system. Given that the hazards at both locations is nuclear radiation, if there were an accident, people living, working, and commuting through the area would not know that they need to take protective action without some kind of warning system. The alert and notification system provides the initial alert that something out of the ordinary has occurred. The notification part of this system gives the public information on what has occurred or may occur, who is at risk or potentially at risk, and what protective actions are recommended.

IEM reviewed Millstone's alert and notification system to independently verify that within the ten-mile emergency planning zone, the system meets the FEMA *Alerting Criteria for Alert and Notification*. This review focuses its attention mainly on the Fishers Island since this is the only region in the plume emergency planning zone that lies within the State of New York, apart from Plum Island which is considered elsewhere. As part of the review, IEM planned to evaluate sound level contours generated from the most recent sound propagation study to check if Fishers Island is covered under the appropriate sound contour.

5.3.3.1 Alert and Notification Independent Review Methodology

IEM's independent review of Millstone's alert and notification system is based on:

- "Millstone Nuclear Power Station-Siren Public Alerting System," prepared by Millstone Nuclear Power Station, December 1998;

This document discuss the plans and procedures that have been designed to best alert the areas surrounding Millstone in the event of an accident, a description of the siren system, and the range calculation and contours from a recent sound propagation study for Millstone.

IEM began the Millstone alert and notification review by studying the demographics and geography of Fishers Island.[77] Next, IEM evaluated the sound propagation model by studying the

[77] Information on the meteorology around Millstone was not supplied to IEM.

predicted sound contour levels. After the evaluation of the sound propagation model, IEM compared the field data of observed sound levels with the FEMA minimum requirements.

5.3.4 Alert and Notification Review Findings for Millstone

This review follows the same sequence of analysis as that of the Indian Point alert and notification system review.

5.3.4.1 Emergency Planning Zone Demography, Geography, and Meteorology

Figure 5-16 shows the Millstone plume emergency planning zone. As can be seen from the figure, only the western half of Fishers Island is actually in Millstone's ten-mile emergency planning zone. This is also the half of the island where the majority of the population is located. The population on Fishers Island reaches a maximum of 4000+ in the summer months, but the population density is still less than 2000 per square mile. Therefore the Fishers Island population needs to be covered by a 60dB sound contour in order to satisfy the FEMA criterion. There does not appear to be any significant topographical variation on the populated portion of Fishers Island within the emergency planning zone.

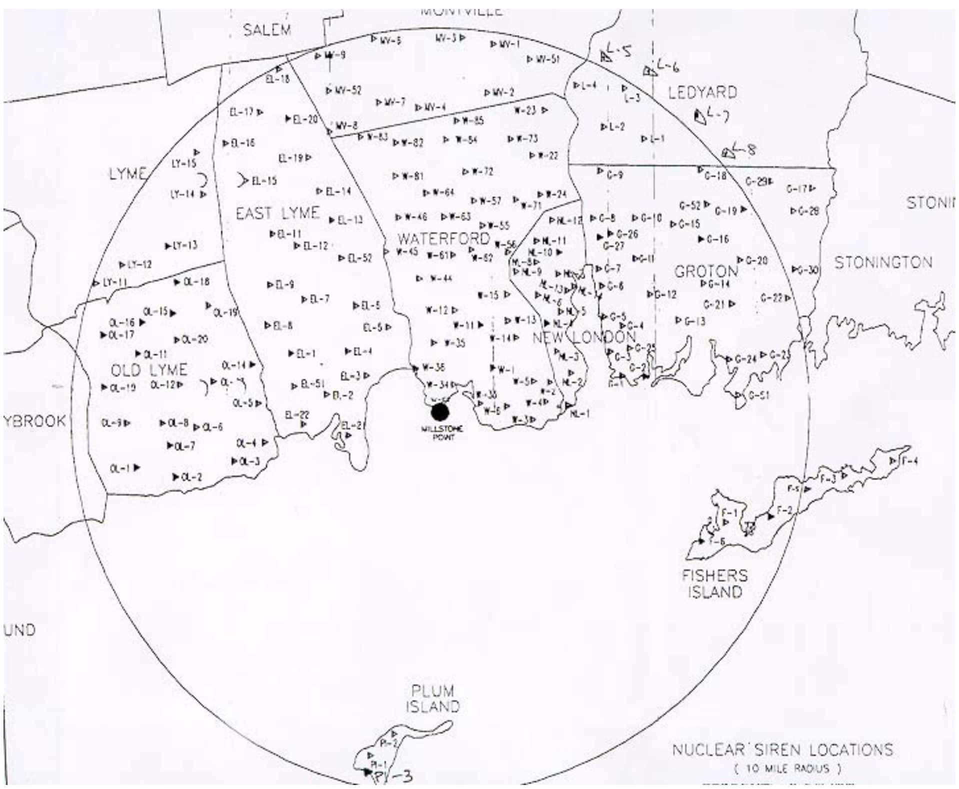

Figure 5-16: Millstone 10-Mile Emergency Planning Zone

5.3.4.2 Review of Alert and Notification Plan

The siren public alert system in the Millstone emergency planning zone consists of 156 sirens, of which, 6 sirens are located on Fishers Island. All sirens are electronic and manufactured by the

Whelen Engineering Company of Deep River, Connecticut. There are different types used based on their output sizes: 109dBC, 112dBC and 115dBC.[78] Each siren produces three different signals, depending upon the type of emergency. No information on backup systems was provided to IEM for this review.

5.3.4.3 Discussion of Sound Propagation Model

The model used to calculate the intensity of sound at Millstone is an extremely heuristic model. The model starts by calculating the range for a siren for 60dB and 70dB sound level ignoring all external effects. It then systematically reduces the range of these sound levels because of the presence of barriers such as hills and buildings. The barrier reduction equations are based on the ones in Federal Highway Administration Highway Traffic Noise Prediction Model. These equations predict that there would be a reduction in sound of about 5-8 decibels when there is a barrier that interrupts the line-of-sight from source to receptor; the sound bounces off and is absorbed in the barrier. If the line-of-sight is not direct in the first place, the reduction of sound from the barrier is even larger, at a reduction of about 20-23 decibels.

The model does not predict any sound levels at receptors that lie over hilltops or abrupt edges of ravines, which renders the model over-conservative. In addition to this, scattering of sound due to tree-lines in forested region is also not taken into account in the model. The scattering makes sound levels increase or stay the same, and since the model ignores the scattering, the model can be considered all the more conservative. Finally, the model does not take into account that sound levels that result from two or more sirens can overlap and increase the overall sound level in an area covered by both sirens. Ignoring this fact also makes the model conservative.

5.3.4.4 Discussion of Sound Contour Levels

Based on the sound contour map provided, it is evident that the 60dB contour covers the entire area of Fishers Island and as such satisfies the FEMA alert and notification criterion. There is, however, a wedge just north of the F1 siren that brings the contour very close to the edge of the north shore of the island. It can be surmised that this effect may be meteorological because of a strong wind pattern blowing from the north. IEM suggests that to be extra-conservative, another tower could be added to push the contour outward farther to the north. For information about IEM's recommendation for Indian Point's use of a state-of-the-art model, refer to Section 5.3.2 of this report.

5.4 Communications System Review

In the midst of an emergency, responders depend on a number of communications systems to transmit critical information and coordinate response and recovery actions. These systems can be as simple as two-way radios or as sophisticated as an interconnected network of computer systems and handheld computer devices. The key to the success of the overall communications

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[78] These sizes are based on tests in a qualified laboratory, sponsored by the manufacturer on representative sirens. The actual sirens are battery powered, with the batteries continually charged from the 120-volt electricity distribution grid.

system is the ability of different types of systems to communicate with each other, or *interoperability*, and the *availability* of the system during an emergency.

The events of September 11, 2001 illustrate the importance of ensuring that emergency communications systems are interoperable and available:

- The World Trade Center was a central communications node for voice and data traffic used by both private entities and emergency management agencies. Thus, the collapse of the towers destroyed the communications backbone for the area.[79] Both the police and fire departments' communications systems were temporarily inoperable as a result of the collapse of the buildings.
- With many communication channels lost, unprecedented network traffic jammed the remaining functional communication links. The disaster generated so much communications traffic that first responders and emergency officials could not use the land-lines and cellular and two-way pager systems that were still functional after the attacks. Not enough radio spectrum was available to support that amount of network traffic, as the system was not designed for that demand. As a result, communications between first responders and federal, state, and local agencies were severely disrupted during and after the hours of attack. This resulted in slower and uncoordinated responses.[80]
- The Emergency Operations Center—the center for coordination of activities during emergencies in New York City—was housed in 7 World Trade Center, which collapsed as a result of the attacks. Consequently, there was no central command to coordinate and control response operations immediately after the collapse. Make-shift command centers were created in and around downtown Manhattan, but they were not sufficiently equipped to handle a situation of such magnitude.[81]
- The New York Police Department and the Fire Department of New York used different communications systems that were not interoperable. As a result, the New York Police Department helicopters flying above the towers were unable to relay information to the Fire Department command center on the ground or to those inside the twin towers regarding the structural damages to the towers.[82]

While the effects on the communication infrastructure caused by the destruction of the World Trade Center may not be the same as the effects expected to be produced by a radiological emergency, this example illustrates the need for emergency communication systems that are interoperable and available. A release at Indian Point will involve emergency personnel from the facility, the State of New York, and four counties. Communications for a response to a release at Millstone will have the added challenge of coordinating with jurisdictions in Connecticut. Communication will be further complicated by the need for effective coordination with many federal agencies, such as the Nuclear Regulatory Commission and FEMA. Emergency personnel

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[79] *First Line of Defense: Tools and Technology Needs of America's First Responders—Investigative Research*, Chapter 2, Accessed at http://www.ists.darmouth.edu/IRIA/fld/fld2.htm.
[80] *First Line of Defense*, page 27.
[81] *Increasing FDNY's Preparedness,* Fire Department of the City of New York, Mckinsey & Company, 2002.
[82] *Increasing FDNY's Preparedness,* Fire Department of the City of New York, Mckinsey & Company, 2002.

must be able to communicate quickly, continuously, and accurately to provide the information needed to manage the rapidly evolving emergency a radiological event would be.

5.4.1 Components of Effective Emergency Communications Systems

The potential for chemical, biological, or other weapons of mass destruction attacks, as well as the ever-present threat of natural disasters such as earthquakes and tornados, demand public safety communication systems that are adequately prepared to protect the security of their communities in light of these threats.

The Association of Public Safety Communications Officials ("APCO") International, the world's oldest and largest non-profit professional public safety communications organization, has identified several initiatives regarding the role of public safety communications in Homeland Security.[83] These initiatives echo recent recommendations by the Gilmore Commission, a committee tasked with providing the US Congress with advice regarding domestic response capabilities for terrorism involving weapons of mass destruction in their December 2001 report.[84] They include *sufficient radio spectrum*, *interoperability*, *redundancy*, and *security*.

5.4.1.1 Radio Spectrum and Interoperability

The radio spectrum is the finite range of frequencies within the electromagnetic spectrum in which radio transmission and detection techniques may be used. It is organized into bands of wavelengths or frequencies such as UHF or VHF, which are then sub-divided into frequencies or megahertz (MHz).[85] The Federal Communications Commission is responsible for managing this limited resource, and issues licenses for groupings of frequencies called channels.

A significant issue for public safety communications is the lack of sufficient available radio spectrum. The Public Safety Wireless Network Program states, "The aggregate amount of radio spectrum allocated for public safety entities cannot satisfy existing day-to-day communications requirements or support interoperability requirements. The overall need for additional spectrum stems from enhanced mission requirements driven by population growth and numerous changes in demographics."[86] This lack of available spectrum has several important consequences on the ability of emergency management agencies and field personnel to meet current communications needs or to plan for the future.

The number of users for any one public safety channel is often too great for effective communications during emergencies. In addition, radio spectrum is no longer just used for voice transmission, but now systems originally utilized for voice carry data, videos, and images.[87] This has resulted in serious congestion of electronic transmissions over the limited radio spectrum. The implementation of new communications tools such as wide-area mobile data systems, which

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[83] APCO. *APCO International Homeland Security White Paper*. August 2002. Accessed at http://www.apco911.org/about/gov/HSTFWP.pdf.
[84] The Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction. *The Third Annual Report to the President and the Congress*. December 2001.
[85] National Telecommunications and Information Administration, Institute for Telecommunication Sciences. *Telecommunications: Glossary of Telecommunication Terms*. FED-STD-1037C. Accessed at http://www.its.bldrdoc.gov/pub/fs-1037/CONTENTS.PDF.
[86] Public Safety Wireless Network Program. *A Progress Report on Public Safety Spectrum*. November 2001.
[87] Smith, Brenna and Tom Tolman. "Can We Talk?" *National Institute of Justice Journal*. April 2000.

can provide not only text communications but also high resolution images, is seriously limited by available spectrum.[88] Perhaps most importantly, the lack of radio spectrum significantly impacts interoperability concerns. Interoperability is defined as the condition of communications systems achieved when information can be exchanged directly and satisfactorily between users.[89]

As was illustrated in the introduction, situations can arise in public safety communications when responders from different agencies responding to the same emergency cannot communicate within and across departmental and jurisdictional boundaries. Without interoperability of communication systems, an emergency response may be uncoordinated, resources may not be utilized to their fullest extent, and perhaps most tragically, information regarding developing events may not easily be disseminated to all responders.

Local, state, and federal governmental public safety agencies currently operate in eleven separate frequency bands and use a varied set of operating modes.[90] Affordable technology does not exist that allows a single radio to communicate across all frequencies in the radio spectrum. In fact, few radios can operate in two or more bands or operating modes. Equipment purchased from one manufacturer is often not capable of communicating with another manufacturer's products.

An example of a technology that allows for effective interoperable communication is trunked radio systems. Trunked systems make efficient use a limited number of radio channels to provide a large number of 'private' talking channels so as to ensure consistent communication and contact between involved agencies. The system is operated by a computer that reassigns channels based in momentary demand, giving very flexible and private access to many groups of users, and reducing frequency crowding.

Additional allocations of radio spectrum to public safety users, especially in adjacent spectrum allocations, will do much to improve the problem of interoperability, both by relieving current congestion and by providing capacity for new technologies.[91] Additional radio spectrum has been recently allocated to public safety, including 2.6 MHz reserved specifically for interoperable communications. The FCC established the Public Safety National Coordination Committee to plan for optimal use of the newly allocated interoperability spectrum.[92] This committee maintains that "wider data channels for higher throughput rates will be the direction technology will pursue to meet operational requirements of public safety users."[93] The NCC is actively involved in developing standards for wideband channels, encryption, narrowband channels, and receivers.

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[88] APCO.
[89] National Telecommunications and Information Administration, Institute for Telecommunication Sciences, page 76.
[90] Federal Communications Commission, Public Safety National Coordination Committee Technology Subcommittee. *Technology Subcommittee Report and Recommendations*. January 2001.
[91] APCO, cited on page 77.
[92] Public Safety Wireless Network. *Radio Spectrum: A Vital Resource for Saving Lives and Protecting Property.* Accessed at: http://www.pswn.gov/library/pdf/radio_spectrum_guide.pdf.
[93] Public Safety National Coordination Committee, Technology Subcommittee, Federal Communications Commission. *Report and Recommendations*. January 19, 2001.

5.4.1.2 Redundancy

Emergency communications systems must be accessible at all times, regardless of the situation. Emergency managers should prepare for primary communications failures during any type of natural or technological emergency. These failures include destruction of the communications hardware (towers, cables, fiber optics, etc.), communications network jamming, computer system hacking, and weak signals, to name a few. The potential for failure of the primary communication system requires that redundancy be built into the overall communications system to anticipate and mitigate any future primary communications failures. APCO states, "By identifying, planning for, and implementing "back-up" or redundant systems, agencies increase the effectiveness of their operations during times of uncertainty or massive attack."[94]

New technologies that have proven themselves in desperate times include wireless pagers, laptops, cell phones, personal digital assistants, hand-held computers, and satellite phones. It is expected that in the next few years, three new satellite services will come on-line, providing voice, fax, data (Internet), video, and radio determination services to portable hand-held phones and palm-top terminals, with little to no terrestrial infrastructure to be damaged in any disaster.[95] One of the biggest advantages of satellite technology is that there is little-to-no use of the terrestrial communication infrastructure, which eliminates or drastically reduces chances of damage due to natural disasters.

5.4.1.3 Security

Public Safety Wireless Network states, "Communications systems security generally includes four components—physical security, network security, communications security and administrative security."[96] Physical security involves protecting facilities such as communications centers, remote tower sites, maintenance facilities, and other communications hardware. Network security includes the protection of the software utilized to operate communications systems. Administrative security involves the use of procedures to guarantee the confidentiality of security plans, procedures, and documentation.

Communications security involves the steps taken to preserve the confidentiality and integrity of radio transmissions. Security of broadcast signals is an issue of increasing importance to public safety communicators, especially in light of escalating concerns of terrorist surveillance. Radio receivers that allow monitoring of public safety and emergency response communications are available to the general public.

5.4.2 Current Communications Technology Inventory

IEM reviewers identified existing communications technology systems and plans in Westchester, Putnam, Orange, and Rockland County Emergency Operations Centers and the New York State Emergency Operations Center, as well as at the Indian Point Emergency Response Organization.

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[94]APCO.
[95]Kendel, Joes. *Keeping up with Disaster Communication Technology,* QST Magazine, October 1998.
[96]Public Safety Wireless Network. *Public Safety Communications Awareness Guide*. Accessed at: http://www.pswn.gov/library/pdf/securitybooklet.pdf.

An inventory of the existing communications systems for each of the aforementioned jurisdictions is detailed in this section (5.4.2).

The inventory list was prepared with information gathered from personnel and radiological emergency plans from Indian Point, the State of New York, and the counties of Westchester, Rockland, Orange, and Putnam.

For the Millstone plant and surrounding jurisdictions, IEM did not have access to detailed inventory information for each responding entity as with Indian Point. For example, we could not review the radiological emergency preparedness plan or communications information for New London County. The Suffolk County plan was written for response to hurricanes and severe storms (not a radiological emergency preparedness plan) and it did not contain detailed information on communications systems specific to a radiological emergency preparedness response. In other cases, information was available, but general in nature (Fishers Island Emergency Operations Center Inventory Checklist). The most complete information was found in the State of Connecticut radiological emergency preparedness plan, the Plum Island radiological emergency preparedness plan and the Millstone plant plan. Much of this information was not applicable to a focused look at the communications impacting the New York population in the ten-mile emergency planning zone. Therefore, a different approach was taken for the Millstone communications review. A separate Millstone section follows the Indian Point discussion below.

5.4.2.1 Indian Point Emergency Response Organization

- The New York State Radiological Emergency Communication System ("RECS") is a dedicated telephone circuit used as the primary means of notification from Indian Point to County Warning Points and to the State and County Emergency Operations Centers. There are 21 stations on the circuit. It is available at all times, and is not used for other purposes.
- The New York State Executive Hotline is a dedicated telephone circuit between Indian Point, the State and counties. It connects the Emergency Director with State and local officials for response coordination.
- The Local Government radio channel is used as a backup to the RECS phone, as is the commercial telephone system via voice and fax transmissions.
- Telephone services used in interagency communications include Private Branch lines and commercial and/or Federal Telephone System exchanges.
- A microwave system provides an alternate means of telephone communication.
- The Emergency Notification System and the Health Physics Network are dial telephone circuits in the Federal Telecommunication System and are used to transmit the initial warning as well as operational information to the Nuclear Regulatory Commission.
- A specialized computer system, Emergency Response Data System, links Indian Point to the Nuclear Regulatory Commission operations center and displays important plant operational data.
- A two-channel radio system allows communication between the Indian Point and emergency facilities. The first channel is connected between the Unit's Control Room and the Con Ed Systems Operator at the New York City Energy Control Center. The

second channel connects Emergency Operations Facility, control rooms and emergency off-site monitoring teams.

- A commercial one-way radio paging system is used to call off-site emergency personnel during an emergency. Pagers are activated by a computer-based system, and a telephone number is provided for responders to verify receipt of the page.
- Medical communication is via commercial telephone lines or by an Indian Point telephone system. Coordinated communications links between medical responders and Indian Point are provided by a dispatcher.
- Public address systems are utilized to page personnel within the Indian Point Protected Area.
- Switched telephone lines are another means of internal communication.
- A separate security radio communication channel exists for internal communication among security personnel.
- Backup power radio systems are gas or diesel generators or batteries which automatically supply power if the normal power is disrupted.

5.4.2.2 New York State

- The New York State Radiological Emergency Communication System ("RECS") is a dedicated telephone circuit. It is the primary means of notification from the Emergency Response Organization to the state and county Emergency Operations Centers.
- The New York State Executive Hotline is a dedicated telephone circuit between the Emergency Response Organization, State, and counties, which connects the Emergency Director with State and local officials.
- Commercial telephone lines connected to federal National Warning Circuits are also used to communicate with the counties.
- Low-band radio communication is a back-up to the interagency communication hotline.
- Radio frequencies link public emergency services.
- Back-up communication with the State Power Authorities is via mobile satellite units (Westinghouse handsets).
- FEMA-based field teams have satellite-based "push-to-talk" radios.
- High frequency e-mail services are present with M/A-COM 3E radio with data options.
- Division of State Police has a statewide police teletype system that allows interagency communication between the local government emergency managers, Disaster Preparedness Commission/State Emergency Management Office, law enforcement agencies, and the National Weather Service.
- The Department of State Police has radio communication, mobile and fixed, that allows statewide communication with different agencies.
- State-of-the-art mobile communication vans with satellite communication capability have been developed and are being operated for Disaster Preparedness Commission by the Department of State Police.
- High Frequency Amateur Radio, operated by New York State RACES volunteers, is used for backup communications to County EOCs and other facilities similarly equipped.
- VHF Amateur Radio is used for backup communications in the Albany area and through a linked repeater system throughout the Hudson Valley.

- VHF Amateur Packet Radio is similarly used and linked via data repeaters throughout the State.

5.4.2.3 Westchester County

- The New York State Radiological Emergency Communication System ("RECS") is a dedicated telephone circuit. It is the primary means of notification from the Emergency Response Organization to the State and County Emergency Operations Centers.
- The New York State Executive Hotline is a dedicated telephone circuit between the Emergency Response Organization, State, and counties that connects the Emergency Director with State and local officials.
- The Emergency Operations Center is capable of maintaining communication with the emergency medical services and county hospitals.
- The Amateur Radio Emergency Service/Radio Amateur Civil Emergency Service (ARES/RACES)[97] provides the following communications services:
    - VHF and UHF local and regional backup or supplementary communications using the Westchester Emergency Communications Association[98] voice repeater and data repeater systems. The primary VHF voice repeater system has backup generator power and the four remote receivers distributed around the country have long-term battery backup. The two secondary UHF repeaters are on the same generator backup system but do not have remote receivers, reducing their coverage somewhat. Several additional repeater systems run by other amateur radio organizations in Westchester are also available.[99]
    - 110 trained, FCC-licensed Amateur Radio Service operators whose homes are distributed throughout the county.
    - Backup and supplementary communications at the EOC, JNC, and decontamination center, as members of County Field Monitoring Teams, in congregate care centers, shelters, and as "shadow" communicators for key personnel as needed.
    - Communications via HF radio from the Westchester EOC to the NYSEMO EOC in Albany and other locations as needed. The HF capability is backed up by member's home stations as well as WECA-owned portable equipment and facilities (tents, portable towers, antennas, transceivers) and the two Red Cross and County OEM vans.
    - Interagency communications with the Westchester County American Red Cross and others as needed.
    - Pre-established mutual aid communications plans in place throughout the Hudson Valley, New York State, the nation and internationally as part of the ARRL ARES national organization. ARRL[100] is a member of NVOAD and has national

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[97] http://www.weca.org/ares.html
[98] http://www.weca.org
[99] Northern Westchester Amateur Repeater Association, Yorktown Heights; Peekskill/Cortland Amateur Repeater Association, Peekskill; Yonkers Amateur Radio Club, Yonkers; and others.
[100] http://

memoranda of understanding with all key players including the American Red cross, Salvation Army, APCO, NWS, NCS, and others.
  - Communications to the American Red Cross chapter headquarters in White Plains and in two field communications vehicles (a mobile command post and a pneumatic mast tower van).
  - Communications for most member hospitals of the Northern Metropolitan Hospital Association. Based in Newburgh, the association is composed of 35 hospitals in 7 counties in the northern metropolitan area of New York State. 16 of Westchester County's 18 member hospitals have permanent rooftop UHF/VHF antennas installed at each hospital and operated by RACES.

- A "Mutual Aid" system is being planned for better utilization of countywide emergency medical services resources. It is still a work plan[101] and considers the various agencies' protocols and lays down the means of making it operational.
- The most recent development in inter- and intra-agency Emergency Operations Center communications has been the use of the Emergency Operations Center E-mail Form[102] accesses from the county laptops on the network by accessing the Emergency Operations Center Intranet site: http://cww/eoc/eocsearch. This system has automated the "Status Board Update" part of Emergency Operations Center activities in an emergency. Each time the Command Center updates and saves the emergency response and planning areas status protective actions form and/or the event condition status log, Emergency Operations Center generic IDs will automatically receive an e-mail notification containing a link to the newly updated form so that all Emergency Operations Center participants can be immediately aware of exactly what is happening.
- The Emergency Operations Center has been set-up with wireless communications systems so that personnel working on laptops can communicate with each other without network cables. The laptops have wireless personal computer cards through which they are connected to each other in the network.
- The back-up in case of a wireless communications failure is the Ethernet Patch Cord (to be supplied by Emergency Operations Center, if necessary)
- The Westchester County Emergency Communication Center[103] ("60-Control") provides dispatch services for the county. The existing communications systems at 60-Control include radios, switched telephone lines, and alpha-numeric 1-way pagers. The fire paging system works on low-band VHF and UHF frequencies, while the emergency medical services operates only on VHF. Commercial wireless services from Cingular are used as means of wireless communications. The 60-Control communicates with 45 emergency medical services agencies, 60 fire agencies, and 42 police departments.
- 60-Control operates 24 hours a day, 7 days a week, and houses the newly instituted E-9-1-1 emergency communication system.[104]

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[101] Westchester County Emergency Medical Services Mutual Aid Plan, Westchester County Department of Emergency Services Division, Valhalla, NY 10595, Approved: June 2000. Revisions: January 18, 2002, March 21, 2002 (http://www.westchestergov.com/emergserv).
[102] *Emergency Operations Center—IT Guide*. Emergency Operations Center, Westchester County, September 2002.
[103] Information source: telephonic interviews with Westchester County 60-Control personnel.
[104] Westchester County Department of Public Safety, *2000 Annual Report*.

- 60-Control recently began operations of a computer-aided dispatch system, which is designed to streamline dispatch operations, improve response time, and increase the accuracy of data.
- The county maintains the state-of-the-art Mobile Command Post and Communications Vehicle which is a large van equipped with communications equipment designed to enhance coordination among various law enforcement and public safety emergency responders by allowing coordinating efforts at the scene of an emergency. It includes capabilities such as VHF, UHF, low-band, cellular, and satellite communications, marine and aviation frequencies, and audio-visual functions. The unit can serve as a backup answering point for the 911 system and provide temporary communications in the event of a power failure.
- There is video-conferencing capability at some hospitals, the Emergency Operations Center, 60-Control, Health department, and County Executive's office.
- Due to heavy costs involved in the set-up, the 800MHz public safety communication capabilities have not been established in this county.

5.4.2.4 Rockland County

- The New York State Radiological Emergency Communication System ("RECS") is a dedicated telephone circuit. It is the primary means of notification from the Emergency Response Organization to the State and County Emergency Operations Centers.
- The New York State Executive Hotline is a dedicated telephone circuit between the Emergency Response Organization, State and Counties which connects the Emergency Director with state and local officials.
- Radio systems include:

– Health Department System/Department of Social Services Communication System

– Local Government System

– Fire Department Communication System

– County Police Department Communication System

– New York State Police Communication System

– County emergency medical service and hospital communication system

– County Highway/New York State Department of Transportation Communication System

– RACES

- The Rockland Mobile Communication Van has communications access to the County Police, County Fire, County emergency medical service Radio Systems and the commercial telephone system.
- Commercial telephone would be used as the primary source of contact between Rockland and many support agencies.
- There are eight different E-9-1-1 systems, with fire dispatch centralized and police and ambulance dispatch in a mix-and-match format (i.e., some are centralized and some not, depending on the jurisdiction and location).
- There is a Mobile Radio District System used for inter-agency communication.

- The fire units have access to the low-band channel (46.180 MHz) as their primary radio and dispatch channel for the entire County. Two low-band fire ground tactical channels are used for ground operations.
- The police operate on a VHF network on a county-wide basis.
- The Sheriff's Communication Division ("44-Control") acts as the primary back-up for the County Public Safety Answering Point. 44-Control is responsible for dispatch of the 26 volunteer fire departments in the County. The communications division has a county-wide radio system in place with VHF low-band, VHF high-band, and 800MHz simplex and duplex radio channels. The county also operates on two microwave links. The communications division can coordinate with the New York State Police Information Network, National Crime Information Center, and the Division of Motor Vehicles, etc.
- The county has several mobile data terminals that operate on the county 800MHz radio system.
- The county also operates a VHF radio network and communication system that can be used by the county-wide police channel shared by all town and villages in the county.
- The Sheriff's department has 36 mobile and 75 portable radios along with 16 MDTs that operate on the 800MHz frequency.
- There are several contract paramedics and ambulance corps that operate within the county using mobile and portable radio communications along with pagers. These agencies transmit on the HEAR frequency to the hospitals, and are capable of receiving signals only when they are within two miles of the hospital. Repeaters are used to extend this range. These agencies also have radios for the different police departments but face coverage problems.

5.4.2.5 Orange County Emergency Operations Center

- The New York State Radiological Emergency Communication System ("RECS") is a dedicated telephone circuit. It is the primary means of notification from the Emergency Response Organization to the State and County Emergency Operations Centers.
- The New York State Executive Hotline is a dedicated telephone circuit between the Emergency Response Organization, State and Counties which connects the Emergency Director with state and local officials.
- In an emergency that needs countywide action, the Orange County Emergency Operations Center notifies the E-9-1-1 Center located at Chester via switched telephone lines and an e-mail system.
- Radio services include:
  - Local government;
  - County fire services;
  - Emergency medical services;
  - Local police service; and
  - Highway maintenance radio service.
- The E-9-1-1 Center is the primary Public Safety Answering Point in the county. There are 18 secondary Public Safety Answering Points all over the county.
- The back-up emergency communication services are located at the county Sheriff's office on a smaller scale.

- E-mail communication systems exist between the Emergency Operations Center and the E-9-1-1 Center.
- All land lines reporting 9-1-1 emergencies are reported at the E-9-1-1 Center. All wireless emergency calls are handled by New York State Police, at Monroe.
- There is an extended computer-aided dispatch system at the center controlling the dispatch.
- Emergency communications from the E-9-1-1 extend among 51 fire departments, 20 emergency medical service agencies, and about 24 police departments, in addition to the State Police.
- The E-9-1-1 Center has a myriad of communications means with the other emergency management services. The County Police operates on 800MHz Hi band trunked system with repeaters. The trunked system is an Ericsson system, called Enhanced Digital Access Communications System.[105]
- The E-9-1-1 center also has cross band functionality through which it can communicate with different agencies' interoperability function.
- The emergency medical service voice communication system is on a Hi band repeater system
- The fire paging system and ambulance corps pager systems operate on Hi band frequencies with remote transmitters located at different hill tops.
- Hospital communications can be directed through specific frequencies in emergencies. These are direct communication frequencies with no repeaters.
- RACES uses the Putnam Emergency and Amateur Repeater League[106] repeater system. RACES can provide back-up or supplemental communications services for the following:[107]
    - Radiological field monitoring and reporting;
    - Radiological decontaminations;
    - Evacuation communications to the Emergency Operations Center;
    - Joint News Center communications to the Emergency Operations Center; and
    - Plant communications to the Emergency Operations Center.
- RACES also provides communications for Northern Metropolitan Hospital Association. Based in Newburgh, the association is composed of 35 hospitals in 7 counties in the northern metropolitan area of New York State.

5.4.2.6 Putnam County

- The New York State Radiological Emergency Communication System ("RECS") is a dedicated telephone circuit. It is the primary means of notification from the Emergency Response Organization to the State and County Emergency Operations Centers.
- The New York State Executive Hotline is a dedicated telephone circuit between the Emergency Response Organization, state, and counties, which connects the Emergency Director with state and local officials.

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[105]Information obtained from Department of Emergency Communications, Orange County.
[106] http://home.computer.net/~pearl/index.html.
[107] http://home.computer.net/~pearl/races.html.

- There are 13 volunteer fire departments, four volunteer ambulance corps, one paid paramedic service using the Fire and emergency medical service radio network.
- Radio services include:
  - Police radio service;
  - Fire/emergency medical service Radio Service;
  - Highway radio service;
  - Local government radio service (used as backup for RECS);
  - RACES; and
  - Emergency medical service frequency is used to communicate with Putnam Hospital Center.
- The 911 radio frequency is shared by the Putnam County Sheriff's Department, New York State Police, Town of Carmel Police, Town of Kent Police, Village of Cold Spring Police, MTA Police, NYC DEP Police, NYS DEC Police, and the Putnam County Probation Department.
- Communications among county law enforcement agencies and the State Police is accomplished over the Mobile Radio Dispatch and the Sheriff's Department Hi band frequency.
- Equipment used between agencies to communicate includes regular hard line telephone, both repeated and simplex radio networks, pagers, and NYSPIN Teletype.
- Nextel cell phones with direct connect capability and e-mail used in the Sheriff's Department and Bureau of Emergency services. Local police and State Police also employ this technology however phone numbers and direct connect identification information are not shared at this time
- Commercial switched telephone circuits are the primary communications service between fixed stations.
- Digital data receivers and facsimile equipments are available in some agencies for receiving information and for process log purposes.
- Putnam County Sheriff's Department has 18 mobile data terminals
- NYSPIN Teletype system used by all but the Village of Cold Spring Police to share law enforcement information.

5.4.3 Analysis of Communications Technology Effectiveness and Related Recommendations

5.4.3.1 Evidence of Effectiveness from Radiological Emergency Preparedness Exercises

JLWA/IEM representatives were present at the county Emergency Operations Centers and at the New York State Emergency Operations Center during the emergency responses exercises that were carried out in September 2002 in coordination with county and state agencies of New York, Indian Point, and Entergy. We evaluated emergency management processes, including emergency communication, during the exercises. We observed the efficacy of the communications systems in place at the state and county Emergency Operations Centers, and took note of the efficiencies with which the authorized Emergency Operations Center personnel used the equipment. In addition, we contacted several individuals with experience in emergency communications systems for police, fire, and emergency medical services at county and state levels. The individuals provided valuable information about existing systems and future directions for emergency management agency communication systems.

In general, communications systems functioned adequately during September's exercise events.

A problem with the RECS dedicated telephone line at Indian Point was noted during the practice exercise. In addition, Indian Point had outdated fax numbers that hampered back-up notification via fax during this practice exercise. The RECS system functioned adequately during the actual exercise.

Indian Point personnel faced problems dispatching field units from the Emergency Response Organization. In addition, there is no direct communications interoperability with the medical response community.

The Executive Hotline connecting the primary Emergency Operations Centers in charge of managing the event malfunctioned during the exercises. Putnam County had trouble receiving hotline calls, as the telephone would not ring. County Emergency Operations Centers were dropped off of the phone bridge network frequently. A backup telephone system was utilized, but it was noted that the backup to the Executive Hotline telephone system did not have speakerphone capability. This forced an individual to have to relay information to others in the Emergency Operations Center when the backup system was in use, which hindered the ability of event commanders to communicate effectively. There were also concerns regarding the quality of the voice signal on this backup system.

Additionally, the State discovered telephone problems in the Command Center, including the phone line ringer in the Command Center being so weak that at times, no one noticed the ring. There were also some problems in establishing an e-mail link between the State Emergency Operations Center and the Joint News Center.

At Putnam County, the radio system used by the Emergency Operations Center to communicate with its field teams was jammed during the exercise. The radio operator was able to switch to the Westchester County system to reestablish communications.

5.4.3.2 Ability to Function during Adverse Consequences

Given the available data, it is very difficult for JLWA/IEM to draw any firm conclusions regarding the ability of Indian Point's communications systems to function during adverse situations. In order to make any firm conclusions and recommendations for upgrades, we would require an in-depth comprehensive technical analysis of current communications capabilities. We recommend that New York consider conducting a detailed formal technical audit of the public safety communications systems in the four counties, to gather further information on such issues as coverage, available spectrum, channel loading, age and projected useful life of the current systems, system interoperability, and to determine what the counties are doing to project and accommodate future demands on their systems.

There are many considerations involved in planning for adverse consequences that will be detailed in the next section. Our purpose is not to make specific recommendations about what technology should be purchased, but rather to provide information regarding the planning process and starting points for locating commercially available equipment that meets the need for efficient and effective public safety communications. Only through thorough planning and the implementation of appropriate technologies can Indian Point effectively improve its public safety communications capabilities.

5.4.3.3 The Need for Effective Planning

Planning

Planning is the first step in meeting the challenges of modern public safety communications needs. New technology that seeks to provide solutions in the arenas of interoperability, spectrum efficiency, redundancy, and security is only useful if it is considered as part of an integrated communications system with the goal of protecting public safety in the light of unforeseen adverse conditions. APCO states, "Effective planning considers the non technology issues before specific solutions are determined." They further stress that technological solutions to communications challenges "should be based upon planning for the needs of the responders."[108]

APCO recommends that a communications plan for responding to terrorist events, which would also apply to radiological emergency situations, should include:

- Interoperability requirements
- Capability of the communications system
- Future system upgrades and expansions
- Incident command escalation / procedures
- Logistics and coordination with critical infrastructure
- Funding sources.[109]

The interoperability problem is created not only by limited and incompatible radio frequency bands or lack of funding to update communications equipment, but also by the more encompassing issue of inadequate planning.[110] There has been a general lack of institutional control with no one clear voice providing standards, management, or leadership in public safety communications. Since the decisions regarding equipment purchases are often made at the local jurisdictional level, and without coordination with adjoining jurisdictions, the interoperability problem is often exacerbated. APCO states, "It takes energy and deliberate planning for different agencies to cross over their geographic, jurisdictional, and organizational boundaries and work together towards creating an interoperable communication system."[111]

The planning process should involve regular feedback from the Indian Point emergency response community to professional organizations such as APCO on perceived homeland security issues, threats, and readiness. Feedback such as this is essential to a national on-going dialog that will

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[108] APCO, cited on page 77.
[109] APCO.
[110] Smith, Brenna.
[111] APCO.

foster the development of new technologies and standards to meet the need of public safety communicators.

Indian Point should use the lessons learned from radiological emergency preparedness exercises to create areas of planning focus for communications improvement. Specifically, an alternative technology to the Executive Hotline should be an area of interest. In addition, the problems that Indian Point Emergency Response Organization had with communicating with field personnel, as well as the lack of direct radio communication with the medical response community warrant planning attention. Improvements should be benchmarked during future exercises to ensure that problems are being solved effectively.

New York State can play a role in communications technology advancement by continually reminding lawmakers and FCC of the need for additional public safety spectrum. The Public Safety Wireless Network Program states, "More states should assert themselves as leaders in efforts to obtain this spectrum resource which is needed nationwide. They and the rest of the public safety community should become more proactive in seeking additional spectrum through legislation and/or advocating their needs to regulatory agencies and the Congress."[112]

APCO is developing a Homeland Security guidance document, which will detail priorities for improving public safety communications, along with methodologies at the federal, state, and local levels to meet these priorities.[113] We recommend that the Indian Point community become involved in this process to share and learn of best practices as well as training and funding opportunities.

Training and Personnel Needs

APCO states that, "Telecommunications personnel have been deemed the "first" first responders, making them the most critical link in the receipt and dispatch of information that is vital to the safety of the entire community."[114] Even when equipped with the best technology in the world, a communicator that is not properly trained to utilize that technology to the fullest is as ineffective as one that has no such technology. In addition, Indian Point should ensure that it is adequately prepared to staff for telecommunications needs to support emergency response for an extreme event.

Funding

The lack of financial resources is an additional obstacle on the pathway to effective and efficient public safety communications systems. Naturally we encourage the Indian Point public safety agencies to explore federal, state, and local funding sources for communications project implementation. In *Understanding Wireless Communications in Public Safety,*[115] the National

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[112] *A Progress Report on Spectrum for Public Safety*.
[113] APCO.
[114] APCO.
[115] National Institute of Justice, National Law Enforcement and Corrections Technology Center. *Understanding Wireless Communications in Public Safety: A Guidebook to Technology, Issues, Planning, and Management*. August 2000.

Law Enforcement and Corrections Technology Center provides a very useful guide which explains many of these funding sources.

5.4.3.4 Planned and Potential Solutions

APCO states, "As part of their ongoing planning, public safety communicators should identify and reach out to known research centers and labs for information on the newest technology"[116]. The lack of research, development, and awareness of new technologies can create an unfortunate impediment to building a secure, interoperable, and redundant public safety communications system.

Interoperability Solutions

Any increases in interoperability increase the probability that communications systems can withstand adverse consequences such as adverse weather or other force Majeure situations.

Rockland County's and Westchester County's Communications Committees have been proactively planning for upgrades to the public safety communications system for the area. They have been successful in obtaining radio spectrum and other resources for the implementation of an integrated communications system[117]. Rockland County has been very proactive in identifying their interoperability challenges and planning for solutions. The County completed a study[118] that identified the existing emergency communications systems and proposed an in-depth plan for improvement. A two-phased, slow growth plan has been formalized for a multiple-channel "trunked" radio communications system in the UHF band for county-wide emergency communications. Phase 1 of the plan will include the strategy of implementation, and Phase 2 will include construction of the infrastructure. The implementation of the system would start with the fire agencies.

We recognize that the New York State Office for Technology has been successful in developing plans for an integrated wireless radio network with statewide coverage that will provide for:

- A digital trunked radio network for both voice and data transmission;
- Autonomous talk groups;
- Interoperability through special/ad hoc talk groups for large-scale emergency situations;
- Voice and data encryption.[119]

The agreement of the four counties to partner as a regional communications entity to function as a Statewide Wireless Network pilot site is a promising step in the right direction. Rockland County is coordinating the effort for selection as a pilot site with the New York State Office of Technology. If the area is selected, state funding can be made available to foster the project.[120]

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[116] APCO.
[117] Personal communication between county executives (C. Scott Vanderhoef, Edward A. Diana, Andrew J. Spano, Robert J. Bondi), and Hon. George E. Pataki regarding Statewide Wireless Network information (http://www.irm.state.ny.us/swn/index.htm). September 20, 2002.
[118] *Radio Communications Analysis and Development of Master Plan for County Wide Public Safety Network*, Final Report, Concepts To Operations, Inc., Annapolis, Maryland, February 2000.
[119] Information accessed at: www.irm.state.ny.us/swn/index.htm.
[120] Personal communication.

We support this effort, as it demonstrates the power that multi-agency consortiums can harness for developing and implementing interoperability solutions.

The addition of a computer system that shows the time-sequenced spread of radiation, integrated with population and evacuation route information would provide much needed interoperability in data transmissions. Such systems are relatively common and should be an integral part of the response system and of exercises. The INEX series of international nuclear exercises emphasized the use of information technology in sharing volumes of hazard information quickly and effectively across countries. In addition, the meteorological data used to calculate the dispersion of radioactive materials at Indian Point is scant. With the added emphasis on nuclear power plant safety, it is important to identify technologies that allow access and use of sufficient, localized weather data.

Redundancy Solutions

In general, the use of dedicated telephone links such as RECS and the Executive Hotline, coupled with radio systems as backups offer a high degree of reliability. They complement each other well because they have very different vulnerability characteristics. Thus, they are less likely to be disrupted by the same kinds of adversities. A tornado that knocked out local telephone service, for instance, would be highly unlikely to also destroy radio transmitter antennae. However, the recent exercise proved that the use of a telephone backup system to the Executive Hotline was less than optimal in providing for clear and effective communications. Emergency response organizations cannot rely on public switched telephone circuits.

Satellite communications systems are extremely resistant to threat of communications infrastructure destruction as they have very little terrestrial infrastructure. They may prove to be an affordable alternative to provide extremely reliable redundant communications systems. An example already in practice by the Indian Point response community is New York State Emergency Operations Center's implementation of satellite technology as a back-up system. They also work with the Division of State Police to maintain mobile communications vans with satellite communication capabilities.

Westchester County's Mobile Command Post is another example of good redundancy planning. It allows on the scene communications coordination in the event of an emergency.

Many public safety agencies utilize commercial wireless networks that due to lack of radio spectrum are prone to congestion, especially during emergency events. As mentioned before, New York is planning a State Wireless Network. Priority access to wireless networks for public safety agencies would provide another layer of reliable communications redundancy. The National Security Telecommunications Advisory Committee is working with the telecommunications industry to develop Cellular Priority Services (CPS), which will give priority in cellular telephone communications to callers involved in national security and emergency preparedness.

Security Solutions

The Public Safety Wireless Network states that, "Communications systems security is the process of developing and implementing specific plans, policies, and procedures to secure public safety communications systems from possible risks and malicious actions."[121]

Coordination with responders to an event at Indian Point will require the use of radio transmissions. The security of these transmissions is not guaranteed. IEM recommends the development of protocols for radio talk that may alleviate some security concerns.

The federal government is focusing on making emergency communication services as secure as possible at all levels of operation. Security measures should be incorporated in the communication systems via digital encryption of radio signals, voice inversion techniques, voice digitization technologies, use of digital cellular and/or PCS (personal communication system) telephone encryption technologies.[122]

The implementation of security measures requires prior planning and the development of a regional emergency plan which should include participation by state or federal governments. This is necessary to ensure that all components of a communications system are using compliant security technologies so that there are no gaps in the overall system, and that security measures do not introduce additional interoperability concerns. Unfortunately, as interoperability in a communications system increases, so does the opportunity for security breaches in access points. Interoperable systems generally contain more redundant communications links, which help to mitigate this effect.[123]

Standardized Equipment Lists

Equipment incompatibilities and the lack of standards contribute significantly to the interoperability problem. Awareness of commercially available equipment that can meet the demands of today's interoperability, security, and redundancy requirements is essential for the successful development of public safety communications systems.

The National Institute of Justice's Advanced Generation of Interoperability for Law Enforcement ("AGILE") program is fostering the development and implementation of inter-operability standards. AGILE's goal is to assist local, state, and federal public safety agencies to achieve interoperability, both in the short and long term.[124]

The Federal Communications Commission has adopted a digital interoperability standard known as APCO's Project 25 (P25). This project is a combined effort of U.S. federal, state, and local governments along with the U.S. Telecommunications Industry Association (TIA). Its purpose is to ensure that digital land mobile communications equipment is interoperable across

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[121] *Public Safety Communications Security Awareness Guide*.
[122] Note that where Amateur Radio is used as a backup or supplement to commercial and government systems, the current FCC rules [47CFR97.113(a)(4), 97.309(b), 97.311(c)(1)] prohibit any encryption in the Amateur Radio Service "…for the purpose of obscuring the meaning of any communication."
[123] Public Safety Wireless Network. "The Role of States in Public Safety Wireless Interoperability." Accessed at http://www.pswn.gov/library/pdf/role_of_the_states_guidebook.pdf.
[124] http://www.agileprogram.org/justnet.html.

manufacturers. Other goals are to optimize radio spectrum efficiency and user-friendliness of the equipment.[125]

The Interagency Board for Equipment Standardization and Interoperability (at the bequest of the National Domestic Preparedness Office) published the Standardized Equipment List in 2001 for interagency response operations in combating weapons of mass destruction terrorism.[126] Included in this document are standards for interoperable communications and information systems which embrace P25 compatibility.

In addition, the National Institute of Justice publishes the *Guide for the Selection of Communication Equipment for Emergency First Responders*[127] which "was developed to assist the emergency first responder community in the evaluation and purchase of communication equipment that can be used in conjunction with chemical and biological protective clothing and respiratory equipment."

5.4.4 Evaluation of Millstone Radiological Emergency Preparedness Communications

Based on the limitations in the communications information we had to analyze and the absence of detailed interview data for all Millstone jurisdictions, the priority for the Millstone review was identification of the systems that directly impacted Fishers or Plum Island notification. The second area reviewed was the general communications connectivity and redundancy within the scope of Fishers and Plum Island response to a radiological event.

The communications supporting a Fishers Island response are detailed in Figure 5-17. Fishers Island is a node on the Emergency Response Notification System—a digital pager notification medium. Primary communication links in an emergency are telephone lines and fax via phone. High Band radio and cell phones are additional redundant means of communication. Fishers Island communicates with the Connecticut Office of Emergency Management Area 4 Coordinator for the purposes of coordinating evacuation or other support. The area coordinator has multiple redundant means of communication with the Connecticut State Emergency Operations Center and the transportation staging area in Stonington, Connecticut—the probable debarkation point for people evacuating on ferries from Fishers Island.

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[125] *A Progress Report on Public Safety Spectrum*, page 77.
[126] www.iab.gov/SEL/sel2001.htm.
[127] National Institute of Justice, Law Enforcement and Corrections Standards and Testing Program. *Guide for the Selection of Communication Equipment for Emergency First Responders, Volume 1.* NIJ Guide 104-00. February 2002.

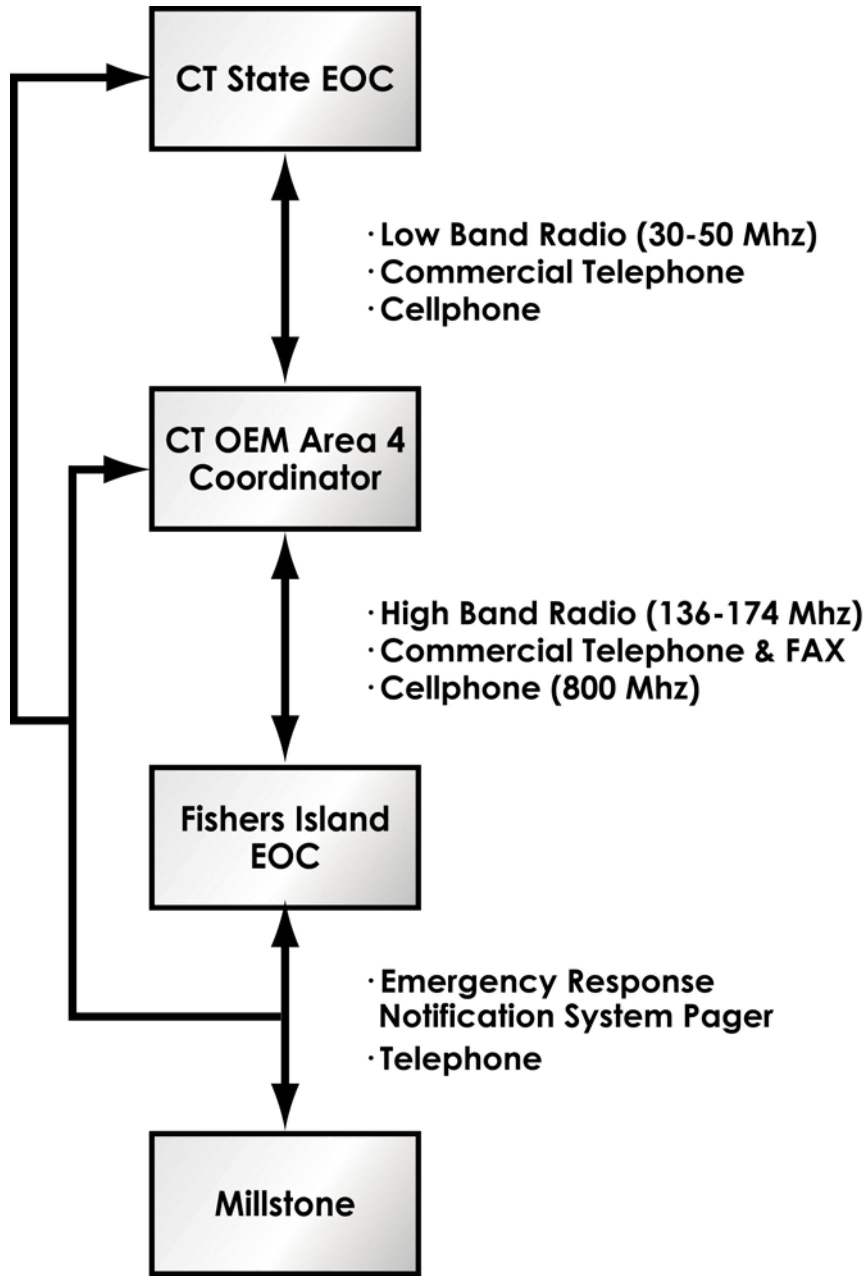

Figure 5-17: Communications Supporting a Fishers Island Response

The Emergency Operations Center Inventory Checklist in the Fishers Island radiological emergency preparedness plan lists the following items in the "communications" section. The items listed are generally consistent with the figure above, summarizing communications information extracted from the State of Connecticut plan.

- Telephones
- Highband Radio
- Fax Machine
- Packet System
- Portable Radios
- AM/FM Radio
- Television

The communications information in the Plum Island radiological emergency preparedness plan is consistent with that specified in both the Fishers Island and Connecticut plans. Plum Island is a node on the Emergency Response Notification System. The disease center has phone and fax lines and cellular access, as well as both High and Low Band radio systems. Responsibilities for the communications systems is clearly delineated in the plan, however reviewers did not have access to maintenance or system testing records.

The Suffolk County plan covers hurricanes and severe weather. It is not a radiological emergency preparedness plan and does not detail radiological emergency preparedness-specific communications. Much of the communications connectivity and redundancy information as related to Plum Island's communication links with Suffolk County came from the Plum Island plan. Supplementary information obtained by New York State Emergency Management Office details the following points:

- Suffolk County has three dedicated phone lines for use in emergencies. These lines have been tested during exercises;
- Suffolk County is a node on the Emergency Response Notification System pager network for the Millstone site. Pagers are installed at both the county Emergency Operations Center and 24 hour warning point;
- All fax transmissions from Millstone are dual routed to the Suffolk County Emergency Operations Center and 24 hour warning point;
- The Suffolk County Department of Fire Rescue and Emergency Services Communications Bureau has a Standard Operating Procedure that details a pager testing schedule, instructions for response to pages, telephoned form information or faxes, required notifications and backup notifications. The required notifications list Southold Town. The backup notifications list Plum Island.

Since there was not a full-scale exercise to evaluate for Millstone, a potential source of communications observations that was available for Indian Point was not available for the Millstone evaluation. Historical exercises and NRC inspection and drill reports were reviewed specifically for communications interoperability and reliability findings. There were no significant findings in those areas for the Millstone plant or other radiological emergency preparedness jurisdictions. Based on the limited review, interview information that was available and the lack of previous communications findings, our judgment is that the communications systems in place are adequate to support the Fishers Island and Plum Island response. There is no direct evidence of significant problems with connectivity or reliability and there is enough redundancy built in via the number of communications options to provide adequate backup.

While the overall Millstone communications posture would certainly benefit from the implementation of the planned and potential solutions detailed for Indian Point in the previous sections, there is not a strong public safety incentive to require changes or upgrades. Reviewers made one general observation that spanned several of the plans, Fishers and Plum Island included. Cellular phones are typically cited as a backup system to the phone systems. The research on actual disasters has shown that cellular networks can quickly be saturated during a response. Based on the high population densities in and outside the Millstone ten-mile emergency planning zone and the likely perceived seriousness of a radiological event by that population, the potential for network saturation is real. This would negate the effectiveness of one communications backup. However, since high or low band radio would still be available, redundancy is still maintained. The only concern if the radio backup were in turn needed would be actual saturation of the radio frequencies by emergency officials or responders and the need for radio net management. The Connecticut State plan details procedures covering these considerations.

CHAPTER 7
Review of Public Information and Education Programs

In general, there is a high level of public awareness of Indian Point and the related controversy about the adequacy of response plans. This heightened awareness can be attributed to many factors, including:

- Concern about the inadequacy of the alert and notification during an event in February, 2000.
- Concern about homeland security in the wake of the terrorist attacks on September 11, 2001.
- Hearings and the issuance of Interim Report dated February 20, 2002, by State Assembly Committees, focusing on the evacuation plan.
- The preparation and dissemination of a report by RBR Consultants, commonly known as the Specter report, addressing alleged inaccuracies and errors found in the above Interim Report.
- Active media coverage and reporting specific to the safety of nuclear power plants.
- Recent county and local hearings, and adoptions of resolutions, calling for the closure of the plant.
- The introduction of the issue into the recent election process.
- The strenuous and public efforts of county and local officials to address the possibility and consequences of a release. The full-scale exercise is one example of this.
- The continuous efforts of a significant number of elected officials who have made closing the plant one of their highest objectives.
- The visibility of active advocacy groups that have access to funding.
- An opinion poll commissioned by Riverkeeper and the frequent use of the resultant report.
- The visibility of the State's contract with JLWA and the importance attached to the effort by both those who want the plant closed and those who want it to remain open.
- To these may be added many of the other, usual factors found when public awareness is high, such as higher education levels, population density, economic interests, life-style implications, etc.

Unlike Indian Point which is located amidst functioning communities (including Buchanan and Peekskill which are home to many of the plant's employees), a large body of water separates the Millstone plant from Long Island, and there are no population centers within ten miles of the plant. Accordingly, the debate surrounding the threat the Millstone plant poses to New York communities is less intense and there seems to be a lower level of general awareness. However, it is the intensity that is less; the nature of the existing public awareness is basically the same. Also, although several of the specific factors described above apply only to Indian Point, there are many in Suffolk County who remember the Shoreham controversy. Thus the findings applicable to Indian Point are also applicable to Millstone.

7.1 Review of Public Education

Awareness and education are both important but differ in their causes and in their consequences. Unfortunately, the myriad of factors that lead to high public awareness (see above) do not also lead to elevated levels of public understanding. In fact, some advocacy groups should bear responsibility for the potential consequences of public misperceptions. For example, in pursuit of their agenda to close Indian Point, some have misused NRC data (see the Limitations and Omissions section for a discussion of CRAC-2), presumably to frighten and alarm the public. Misuse of information can lead to behavior that may endanger public health and safety.

It is regrettable that those responsible for public education have not been able to take advantage of this heightened awareness. More important, as it relates to our review, the anomaly of high awareness and low education impacts the workability of the emergency response plans.
The quality of public education, vis-à-vis awareness, seriously limited the amount of productive interaction we could have with the public. Some thought we were naïve to want to improve something that they thought to be obviously and irretrievably flawed. Some questioned the independent nature of our review and did not want to assist our efforts. Others feared that the adoption of our recommendations would only help to make a defective plan more workable and therefore slow the drive to close the plant. As a result, they were reluctant to provide ideas for improvement. Still others, lacking technical expertise and distrusting plant and government public information materials, decided that their understanding of the risk was insufficient to make an informed decision. For many of them it appeared that the best option was to close the plant because they believed that only then would they eliminate the risk altogether.

It is relevant to note that the information provided and promoted by advocacy groups is readily available, professionally produced, and solicits an emotional reaction. The State, Counties and the plant(s) provide information that is factual and well presented. However, because they cannot use some of the same approaches as advocacy groups, they are ineffective in comparison. Unfortunately, this may foster public opinion and actions that may not be accurate or representative of the facts and issues involved.

This is true regarding Millstone as well as Indian Point. As mentioned earlier, the debate about Millstone's future is less intense on Long Island and the efforts of local officials are also less, as is instanced by the lack of a radiological protection element in the county plan. The issues and findings related to public education are the same, but are less dramatically encountered.

7.2 Review of Public Information—Indian Point

Effective public information materials should be clear and comprehensive, and when combined with effective public outreach methods, help to establish the trustworthiness of the authorities that distribute them. Using this standard, we reviewed the public information materials distributed by Westchester, Rockland, and Putnam counties to gauge their effectiveness in informing residents of their role in emergency response plans. As mentioned above, there is significant room for improvement.

7.2.1 Printed Materials—Indian Point

Westchester, Rockland, and Putnam Counties' primary vehicle for disseminating information regarding Indian Point is the "Planning for Emergency Booklet" (emergency booklet). Last year, the emergency booklet was sent to all households in the 10-mile EPZ. This booklet provides general information about what to do in the event of a natural disaster as well as specific information about nuclear preparedness for Indian Point. The section entitled, "How Would You Know if There is an Emergency at Indian Point" contains information about sirens, the emergency alert system, emergency planning, emergency classifications and radiation. It also discusses aspects of an emergency response such as the protocols for evacuation and sheltering, information for local schools, steps to protect agricultural products in a garden, and caring for disabled people.

Recognizing the need for a more detailed emergency guide targeted specifically to Indian Point vicinity residents, the New York State Emergency Management Office and Indian Point's four surrounding counties worked with Entergy to create the 2002 "Emergency Planning for Indian Point: A Guide for You and Your Family."

Our review will focus on this guide as it is the major piece of officially distributed information available to the public. With the exception of Rockland County, which includes the guide in its phonebooks, the Counties limit direct mailing of the booklet to households within the 10 mile EPZ. This means that many people who may be affected by an event do not receive pertinent information. It also has many areas lacking in content, which are noted below. However, it is an improvement over its predecessor in a number of ways. Instead of presenting the information solely in a narrative format, it is designed as a workbook. To engage the target audience and foster higher information retention rates, the guide is interspersed with questions and a variety of activities. Some activities have specific outcomes such as the creation of a family emergency plan or a wallet-size card containing pertinent emergency information.

The booklet also includes updated information and improved content in some sections. It reflects changes to the emergency response plan and identifies the locations of School Reception Centers (SRCs). SRCs are where parents would be reunited with children in the case of an emergency during the school day. It also identifies General Population Reception Centers (GPRCs) where other family members can reunite at other times. A new map also allows residents to easily identify their Emergency Response Planning Areas (ERPAs). The booklet outlines the types of emergencies, associated siren notification, and appropriate public action(s). Additionally, the booklet educates residents about radiation and characteristics of a radioactive release. If requested, the Emergency booklet is also available in Spanish in Westchester and Rockland. Rockland residents can also request the guide in French and Hebrew.

Below we have reviewed the sections of the 2002 guide.

Be Prepared: Preparing for an Emergency Means Planning Ahead

This is an introduction to the booklet and lists county and the state numbers to call for general information about Indian Point. There is also a map showing the 10 mile EPZ.

Emergency Response: How Will You Know If There is an Emergency?

The section of the booklet on sirens familiarizes residents with this form of notification, what it means, and what actions they should take in response. The booklet clearly identifies the sound residents should associate with an emergency and reinforces that the siren's purpose is to alert residents of an emergency, not to direct them to evacuate. It also seeks to mitigate potential confusion surrounding siren tests. Residents are encouraged to tune to their emergency broadcast station. However, the booklet fails to provide residents with an active way to obtain more information, such as an emergency phone number.

The booklet advises that if you hear a siren but there is no emergency broadcast then the sirens may have malfunctioned or it is a test. In the September 5, 2002 drill a decision was made to activate the EAS three minutes after the sirens. For those who are listening to radio or television when the sirens sound, and who hear no emergency message for several minutes, there is potential for confusion. We are advised that, the three-minute delay is necessary to allow people to tune in to the media, and for the sirens to be quieted, because broadcasters will not repeat the message. If that is the root of the issue then broadcaster unwillingness to repeat emergency messages should be directly addressed as an additional problem.

Different Responses for Different Emergencies

This section outlines the four emergency levels in an easy, comprehensible manner listing the definition of each level, the action the public should take, and the accompanying siren activation. However, it does not provide examples about what types of events constitute a specific level of emergency.

The booklet also points out that a plant emergency can change over a period of hours or days. There is no discussion, however, of the protocol for changing emergency levels or who has the authority to make the change and announce it to the public. The lack of clear protocols and pre-identified authority figures creates potential for confusion and lack of confidence in emergency information and the credibility of the source.

Your Family Emergency Plan

Individual planning is a key component to the success of an effective emergency response at Indian Point. The booklet's format encourages residents to consider the information which is pertinent to them and their families, and thus fosters forethought into family emergency planning. For example, a section called "Emergency Planning Zone and Evacuation Notes" describes ERPAs, General Population Reception Centers (GRPC), and School Reception Centers (SRC). Directly below, residents are asked to fill in their ERPA, GPRC, SRC, and contingency information if their family is separated. This activity has good intentions, but it needs to be supported by additional outreach activities targeted towards families.

For example, publicizing a family emergency planning month and sponsoring community activities would encourage residents to adopt their own family emergency plan. A public official could designate a month dedicated to emergency preparedness awareness of all hazards—man-made or natural. Many of the steps for family preparedness for an emergency at Indian Point are applicable to other hazards, such as flooding or severe storms. For instance, providing information on creating a three day survival kit for family members would be helpful if there were a severe winter storm and the power was knocked out for several days. Promoting activities such as these would greatly improve individual responsibility in emergency planning.

Sheltering—Staying Indoors

The booklet's reference to sheltering is cursory. The booklet mentions that "staying inside can be an effective way to avoid exposure to radiation," but does not further substantiate this claim. There are no examples of emergency situations in which sheltering is advisable or a discussion of the benefits of sheltering over evacuation. The booklet also neglects to discuss the varying degrees of protection offered by different construction materials. It omits some protective measures which help increase the effectiveness of sheltering. For example, sealing windows and doors with duct tape and using wet blankets to further seal openings help to reduce radiation exposure even more. Given the heightened concern of the danger of an event at Indian Point, it is unlikely that residents will consider sheltering as a viable protective measure unless they understand the benefits of this option.

Evacuation

Many residents may evacuate as soon as they are notified of an emergency at the plant, even when evacuation is not necessary. While the evacuation section addresses what you should do before you leave your house and where you should turn for information, it does not address the dangers and risks of mass simultaneous evacuation. Effectively educating the public of instances when evacuation is not advised and the potential harm of unplanned evacuation is essential to emergency preparedness and public safety.

The evacuation plan section advises to "agree on a 'check-in' phone number for the family—a friend or relative who lives outside the Emergency Planning Zone." Because local phone lines beyond the 10 mile zone will undoubtedly be jammed this advice is unsound. The "check-in" number must be outside of the calling area to have much utility as a "check-in" number.

Emergency Planning and Schools

This section of the guide addresses one of the key considerations in emergency evacuation planning: how to evacuate school children if an incident occurs during the day when parents and students are separated. Careful communication of the plan is critical to an orderly evacuation.

This section of the booklet has serious shortcomings. It does not describe all of the procedures that will be carried out in evacuating school children, and thus fails to educate residents on the emergency response plan. Emergency response plans for each of the counties indicate that students will be retained at SRCs until they are:

- returned to their evacuated school, or
- picked up by their parents or designees, or
- transported to a Congregate Care Center[127]

[127]All county plans include this procedure. For example, it can be found in *Rockland County Radiological Emergency Preparedness Plan,* Section III, 30-31.

The emergency booklet, however, does not mention that students could be moved to a new location, nor does it explain the circumstances under which this would occur. If children are moved, residents following the information provided in the booklet may show up at their designated SRC to pick up their children only to be told that they have been moved elsewhere.

The language used in this section is clear, but directions are not substantiated with explanations. Parents are supposed to leave their children in the care of school authorities who will evacuate them to pre-designated School Reception Centers where parents and children will reunite The only explanation for this procedure is that picking up children at school might delay the evacuation process. This is not convincing and does not instill confidence in school authorities. For example, it would be helpful to describe the training that teachers and other school representatives have completed which will help them to effectively evacuate and care for children during an emergency.

Six Facts You Need to Know About KI-Potassium Iodide

This section answers six common questions about KI-potassium iodide, including what it is, how it works and how to obtain these pills for your family. Information about KI accompanied the distribution of the pills to residents. However, this section of the booklet neglects to discuss several important issues such as the side effects of the medication, how to recognize them, and what to do if a side effect occurs. There is also no discussion of whether there are any negative implications to taking a pill unnecessarily. Also, it is important to note that the booklet does not address issues concerning the dose recommended for children and infants versus adults.

Emergency Planning and Evacuation Notes

This section defines Emergency Planning Zone, Emergency Response Planning Area, School Reception Area and General Population Reception Area. It encourages readers to write down their emergency planning information, including where there children's school reception area would be and where the nearest general reception area would be.

This section also provides a pullout map with recommended evacuation routes. While this serves to educate the public in a non-emergency situation, the booklet may not be readily accessible in actual emergency situations, unless it is put into the phone book as is done in Rockland County. We recommend other ways of distributing this information in Chapter 11, and elsewhere in this section of our report.

Planning for People with Special Needs

This section encourages residents to identify individuals with special needs and alludes to a plan of action to evacuate them, but does not explain it well. Residents with special needs are directed to fill out and mail in the card that can be found in the back of the booklet. Visually impaired people may not be able to read the small print. One solution is to provide a large print version of the materials.

We are unaware of additional Indian Point educational materials targeted toward segments of the population with special needs. Although Rockland County does some direct outreach to these segments of the population, we did not find evidence of consistent outreach.

Protecting Your Pets
This section provides general and adequate guidance on protecting your pets.

Protecting Your Agricultural Products and Gardens
This part advises the reader that general instructions would be issued from the New York State Department of Agriculture. It also lists some simple, helpful steps to take in an emergency.

Emergency Planning Check List
This section includes a good worksheet to fill out to help you think about all the items you may need if you have to leave for three days.

Helpful Answers to Some of Your Questions
This section contains a well designed Question and Answer page.

Understanding Indian Point and Nuclear Energy
This page contains basic information such as location, plant type and safety systems at Indian Point. Plant security is discussed in the Q&A above.

What is Radiation?
The explanation of radiation addresses the topic in a simple and easily understood way, but the discussion is not comprehensive. This section is helpful for raising awareness about radiation in general, but does not contain pertinent information about preventing exposure or about Indian Point's radiation monitoring procedures. The previous year's booklet included a section on radiation protection, with recommended actions for limiting radiation exposure. It also assured residents that Indian Point constantly monitors radiation both inside and outside of the plant. Educating residents about Indian Point's monitoring procedures helps to instill confidence in Indian Point's operations and procedures. Furthermore, the booklet does not explain potential health hazards associated with radiation exposure, but should. This section also existed in the previous booklet but was omitted. This may cause concern for those who view this omission as withholding information. The booklet should be revised to include this information.

Additionally, this section contains an unqualified statement that is cause for concern. It says, "There has never been an accident at U.S. nuclear power plants that affected public health and safety, including Three Mile Island." Regardless of the technical accuracy of the statement, the public's perception is undoubtedly that there was an accident at TMI that affected public health and safety. It would be hard to compose a sentence more damaging to the credibility of the document and public authorities than that one sentence. This is a good example of why public education should involve people representing a variety of interests and viewpoints within the community served.

Radioactive Plumes
The section on radioactive plumes did not exist in previous booklets. The addition was an important step. Explaining this concept to residents is important for helping them better understand the risk and their role in emergency response plans. Clearly explaining that although they might live in the ten-mile EPZ, they will not always be immediately affected by an event at

Indian Point is important to prevent unnecessary evacuations. A visual illustration of the "keyhole" concept of evacuation ("two miles around the plant and five miles downwind") would measurably improve this section.

Additionally, because residents are wary of the information coming from the utility and to some extent their county government, it may be useful to bring in an independent expert to explain this issue. A mailing of the explanation could be sent to residents and placed in local papers.

7.2.2 Internet Resources—Indian Point

There are several sources of information regarding radiological preparedness that the States and counties make available for the public on the Internet. The State of New York has a webpage dedicated to radiological preparedness prepared by the New York State Emergency Management Organization Office of Community Affairs (http://www.nysemo.state.ny.us/radiological.html). This page presents the State's emergency response plan for radiological events. It does not however provide any links to the county plans, or to any other resources about Indian Point. Nor does the page have a narrative explanation that helps readers understand the information presented. There is insufficient explanation of the relative responsibility of the State and the counties in an emergency response.

The counties each have their own websites. Several have information regarding Indian Point and radiological preparedness and planning. The Rockland County main webpage[128] has a prominent section called "Featured Links." The first two links under this section are "Emergency Planning Guide" and "Emergency Planning for Indian Point." The first link is a the electronic version (pdf format) of a twelve page guide that lists emergency procedures for incidents such as hurricanes, flooding, tornados, power outages, fires, and hazardous material events. There is no mention of radiological preparedness other on the last page called "Internet Resources for Emergency Planning." This page merely contains links to other websites. The second link, "Emergency Planning for Indian Point" pulls up the electronic file of Rockland's version of the "Emergency Planning for Indian Point: A Guide for You and Your Family" (emergency booklet) which is discussed in detail above. As the general emergency planning guide is presented as an all-hazards discussion of emergency, the omission of radiological preparedness is conspicuous. At the very least, there should be a note that residents wanting information on emergency planning at Indian Point should consult the Indian Point guide.

The Rockland County website also has a link called "Indian Point Interactive Mapping System: What ERPA Are You In?" This link takes the user to a GIS (geographic information system) map displaying Rockland County in relation to Indian Point. Easy to understand instructions on how to use the map can be accessed by clicking on a button labeled for first-time users. The map is marked with the 10-mile EPZ and has layers which the user can turn on and off such as the Emergency Response Planning Areas (ERPAs) the reception centers, roads, towns, the census blocks, and other geographical features like lakes and parks. The map's basic features and tools allow residents to zoom in and out, pan in all directions, select a particular rectangular section of the map, and measure distances on the map (such as the distance from Indian Point to a particular

[128] www.rocklandcountygov.com

location). Another tab called "School Evacuations" lists school names along with the name of their appropriate School Reception Center (SRC) and provides written driving directions to them. Its search capability allows residents to look up a location such as a home or school by address, intersection, owner, census block or PIN. The location is then marked on the map with an arrow and a table to the side of the map lists the ERPA and School Reception Center associated with that address. There is a disclaimer that pops up in a separate box each time the website is opened letting the user know that Rockland County "…makes no representation as to the accuracy of the information or its suitability for any purpose" and IDSi, the company that developed and hosts the map, make no guarantee "to the correctness or accuracy of the datasets used." [129] The introduction of a dynamic GIS map is an innovative way to use technology to communicate with the public. However, several residents did note to us that when they entered their address in the search feature, it was not correctly identified on the map.

The homepage for Putnam County[130] has a link to the Bureau of Emergency Services webpage[131]. This webpage has several notable features relevant to radiological preparedness. It has prominently displayed button that is labeled "Emergency in progress when flashing." Clicking on the flashing button opens up a new webpage where the county can post information about an emergency as it is occurring. Under "Important Links" there is information on potassium iodide (KI), including information about the next KI distribution date and a general fact sheet, which is sponsored by the health department about KI, its benefits, and potential harms. These links provide useful and straightforward information. There is also a link to Putnam County's version of the emergency booklet.

We could not find any links on the Orange County[132] website to emergency preparedness information or planning information related to Indian Point. Nor was there a link to the electronic version of the emergency booklet.

Westchester County[133] has the most substantial web resources on Indian Point. The Westchester homepage has Indian Point listed under its "Popular Places" section. Clicking on this link opens up a webpage completely dedicated to Indian Point[134]. The webpage is easy to navigate and laid out well. A side bar of links on the left side of the page lists the sub-links of information available on the page including, "Do I live in the 10-mile EPZ?," a link an electronic version of the emergency booklet, KI information, a current news page displaying county press releases and articles, a glossary of terms, and links to other emergency planning websites. In addition, the purpose of each of these links is described in a narrative format in the main body of the webpage. This helps to orient the user and put the information in context. The last main feature of the webpage is a message from the County Executive underscoring the importance of planning and preparing for an emergency at Indian Point while at the same time denouncing the existence of the plant.

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[129] http://idsigis.com/rockland/start.asp?tfw=400
[130] www.putnamcountyny.com
[131] www.pcbes.gov
[132] www.co.orange.ny.us/
[133] www.westchestergov.com/
[134] www.westchestergov.com/indianpoint/

Clicking on the "Do I live in the 10-mile radius of Indian Point?" opens up a GIS map called "Indian Point Evacuation Plan." This map allows residents to search for an address by street number and zip code. Correctly entering an address will mark the address on the map and identify its associated ERPA and SRC. As with Rockland, a disclaimer advises the user that

The link called "Emergency Planning for Indian Point Booklet 2002" directs the user to a webpage which presents narrative information. The main portion of the page contains a section for each of the four counties affected by Indian Point, identifying their respective emergency response organizations, toll free numbers residents can call for non-emergency information and questions, and links to the electronic copy of each county's version of the emergency booklet. Although Westchester booklet is available in both English and Spanish versions on the website, the other counties' booklets are available only in English. On the right side of the page, text introduces emergency notification procedures such as sirens and the emergency alert system radio stations. The text also includes basic information about the various possible public responses to an emergency (sheltering and evacuation) and directs the reader to the emergency booklet for more specific information. By including this introductory information, the website puts the booklet in context, captures some of its main points, and encourages residents to read the booklet carefully for further information.

The information available on KI through the Westchester site is presented in a question and answer format which is easy to follow and helpful. The website properly points out that KI is not a substitute for taking other emergency precautions such as evacuation, sheltering, and control of foodstuffs. Another beneficial feature of the site is its link to an interactive map that allows users to search for pharmacies which distribute KI.

In addition to the information that the State and counties publish, there are innumerable other sources of information available to the public on the internet. Many groups on both sides of the debate maintain sophisticated websites with numerous links to other sites, articles, songs, video clips, reports, and other information on Indian Point. Entergy, the operator of the plant, has also developed a site on Indian Point whose main purpose is to promote the plant[135]. The page is relevant because it is published by the plant's operator, one of the main agents involved in an emergency response. Knowing this, many residents may turn to the site for emergency planning information.[136] As such, it is worthy to note that the site does not provide links to the county websites or to an electronic version of the emergency booklet. Additionally, many residents may be directed to a site through a web search. When searching several different search engines (including www.google.com and www.yahoo.com) for information on "Indian Point and emergency planning" or just "Indian Point", the Entergy sites appear in the top two listings.

[135] The site can be accessed through three different web addresses: www.safesecurevital.com, www.safesecurevital.org, and http://www.indianpointenergycenter.com/.

[136] According a Nielson//Net Rating Report from October, 2002, Google and Yahoo are the two most popular search engines, and are used by an estimated 59.7% net surfers.

7.3 Review of Public Information Materials—Millstone

7.3.1 Printed Materials—Millstone

The primary public education piece for Millstone Nuclear Power Plant is *Emergency Planning at Millstone Station: A Guidebook for Our Neighbors.* The Connecticut Office of Emergency Management is tasked with creating this booklet and working with the operators of Millstone to assure that the public is aware of emergency preparedness plans and procedures. Although this booklet is produced by the State of Connecticut, it is sent to all residents in the 10 mile EPZ, including Fishers Island, NY. Residents can order a copy in Spanish by calling a number on the front of the booklet. The booklet also provides a phone number for those residents with special needs, who can register themselves and let the county know what type of assistance they would need in an emergency.

According to its introduction, the booklet is provided in the front cover of the yellow pages phonebook of the communities in the EPZ. The booklet also explains that the county has made an effort to place evacuation brochures and weather-proofed evacuation signs in conspicuous places throughout the EPZ to draw the attention of both visitors and workers who are not permanent residents of the county. Although the introduction lists a number to call for more information in a non-emergency situation, there is no hotline number available for people to call during an event.

The booklet begins with several checklists which are helpful for highlighting specific action steps that residents need to take to prepare for and respond to an emergency. These include: a Preparation Checklist, a Sheltering Checklist and an Evacuation Checklist. However, if the guide resembled more of a workbook, requiring the reader to write out, identify, and fill in information pertinent to him or her, it would promote retention of the information presented.

The sections of the guide are reviewed below. Of particular note, there is no section which promotes family emergency planning.

What is a nuclear power plant emergency?
This is a brief explanation about when a nuclear power plant emergency occurs when there is a release of radioactive material. It is very general and vague and creates more questions than it answers. For example, the section mentions that an accident could result in "people being exposed to radioactivity and receiving a radiation doses," but there is no further discussion of the health hazards of radiation here or in any other section of the booklet. All discussion of radiation in the booklet portrays it in the most positive light possible. A forthright discussion of radiation and its potential harms combined with a discussion of radiation doses from various familiar sources such as chest X-rays would be a credible way of presenting the information without causing unnecessary concern. Because of heightened awareness in the community of the radiological hazard, the omission of health hazards is obvious and therefore likely to undermine authority's credibility.

How will you know that an emergency exists?
This section describes the number and type of sirens that are located in the 10 mile EPZ. It also details the type of tones emitted from the sirens not only for a nuclear plant emergency but also for an enemy attack, fire or severe weather. The booklet indicates that the alert for both natural disasters and nuclear plant emergencies are the same, a steady three-minute tone. Given the heightened awareness about nuclear power plants preparedness and security, the lack of distinction between different emergencies could have unintended results. In a non-radiological emergency, people may misinterpret the siren and spontaneously evacuate even though evacuation is unnecessary. Since there is no emergency hotline number to call, there may be initial confusion as to whether there is a natural disaster or a nuclear power plant emergency when the sirens sound.

The Emergency Alert System
This lists the different radio and television stations that a citizen should listen to for emergency information.

What should you do in a nuclear power plant emergency?
The section of the booklet encourages residents to stay calm and tune into a local emergency alert station for more information if they hear a steady siren tone. The booklet reinforces that the siren's purpose is to alert residents of an emergency, not to direct them to evacuate. Although the booklet emphasizes that it would take hours for an emergency situation to develop, it does not provide additional details about why this is true. It would be helpful to have additional information about why it takes hours for a nuclear emergency to develop. The more information a resident knows about a possible nuclear emergency and how it develops, the better chance that they will take the correct protective actions.

If you are directed to take shelter
The booklet explains how to take shelter but does not give the reasons why. There are no examples of emergency situations in which sheltering is advisable. Nor is there a discussion of the benefits of sheltering over evacuation or that the varying degrees of protection offered by different construction materials. The booklet also neglects to discuss the varying degrees of protection offered by different construction materials. It omits some protective measures which would help increase the effectiveness of sheltering. For example, sealing windows and doors with duct tape and using wet blankets to further seal openings help to reduce radiation exposure even more. It is unlikely that residents will consider sheltering as a viable protective measure unless they understand the benefits of this option.

If you are directed to evacuate
This part of the booklet discusses how each community in the 10 mile EPZ has been designated a host community which will receive them in the event of an emergency and is located at least 15 miles from the plant. Host communities and an evacuation route are marked on a map which follows this part of the booklet. There is no information for Fishers Island regarding ferry operators or on the procedures for evacuation by ferry.

What if your children are in school or daycare?
This section of the guide addresses one of the key considerations in emergency evacuation planning: how school children are evacuated or sheltered if an incident occurs during the day when parents and students are separated. Careful communication of the plan is critical to an orderly evacuation.

As in the similar section in the Indian Point booklet, the language used in this section is clear, but directions are not substantiated with explanations. Parents are supposed to leave their children in the care of school authorities who will evacuate them to pre-designated host community reception centers where parents and children will reunite. The explanation for this procedure is that picking up children at school would cause traffic problems and prevent the timely evacuation of students. This argument needs to be more convincing and does not instill confidence in school authorities. For example, if possible, it would be helpful to describe the training that teachers and other school representatives have completed which help them to effectively evacuate and care for children during an emergency.

What if you have special needs?
This section encourages citizens with special needs to register with "your community's Office of Emergency Preparedness or Civil Preparedness Office" or "your Visiting Nurses Service". Connecticut does distribute a confidential Emergency Assistance Survey to find out the special needs of citizens. Although the Indian Point approach has been faulted on the grounds that too few cards are returned, it may still be preferable to requiring those with special needs to make extra efforts. They also may want to consider publishing the booklet in large print for the visually impaired.

How will you know the emergency has ended?
This brief paragraph lets resident know that once an emergency has passed, they will be notified through the Emergency Alert System or by the news media.

For more information
This section lists websites and the phone number and address for the Connecticut Office of Emergency Management to contact for additional information.

Where does radiation come from?
The explanation of natural and man made radiation addresses the topic in a simple and easily understood way, but the discussion is not comprehensive. This section is helpful for raising awareness about radiation in general, but does not contain pertinent information about preventing exposure or about Millstone's radiation monitoring procedures. Educating residents about Millstone's monitoring procedures helps to instill confidence in its operations and procedures. Furthermore, the section does not explain potential health hazards associated with radiation exposure. Engaging in a forthright discussion of the hazards of radiation exposure is an important way to earn credibility with residents.

There is a discussion about the Three Mile Island incident in 1979 and how the radioactivity was contained, which may increase or decrease fears about radiation exposure. But their treatment of TMI is vastly superior to that found in the Indian Point booklet.

How quickly would a nuclear power plant emergency develop?
This section lists the several layers of protection that a nuclear plant has to prevent an emergency from taking place. Although it details that "it would probably take hours or days to develop," it does not explain why. Making this statement without evidence or support does little to make a person feel at ease. A more thorough explanation of the development of a nuclear emergency would be extremely helpful and again, likely to encourage residents to take the appropriate action if an event occurs. Finally, there is a discussion about the event at Chernobyl in 1986 and why a similar type of event could not occur here. As comparisons to Chernobyl are frequently heard, emphasis on the containment structure differences is important, and is found in a brief sentence.

How are nuclear power plant emergencies prevented?
This section is helpful as it describes the safety, construction, maintenance and inspection programs at Millstone that would prevent or significantly postpone an emergency or a release of radioactivity to the environment.

Who could be affected in a nuclear emergency?
This section mentions that not all residents who live within the 10 mile EPZ of the plant would be affected by a nuclear emergency. The explanation in this section is clear and concise, but never directly names the concept on which it is based—the concept of radioactive plumes. It merely explains that the portion of the EPZ that is affected will depend on the amount of radioactivity released and the wind speed and direction. This part is helpful as it talks briefly about when you may have to evacuate and when you may have to shelter-in-place. However, the section is brief and a more in-depth discussion about the benefits of sheltering (as mentioned above for Indian Point) would increase overall understanding about what to do during a nuclear emergency. It would be helpful if the booklet explained the reason for the statement that "Many lower types of nuclear incidents would not require the public to take any actions." There is too much suspicion of the government and the plant for statements like that to be unsupported by a reason. Again, with increased education of citizens, it is more likely that they will take the correct, protective actions if an event should take place.

Nuclear emergency classifications
This section describes the four nuclear emergency classification levels and provides an example of what could occur at the plant for an event to be designated at that level. This provides a good, preliminary explanation for citizens.

The booklet concludes with ways to contact the Millstone Discovery Center or the Connecticut Office of Emergency Management for additional information on nuclear emergency plans.

7.3.2 Internet Resources—Millstone

There are several sources of information regarding radiological preparedness that Connecticut makes available for the public on the internet. The State of Connecticut has a webpage dedicated to radiological preparedness prepared by their Office of Emergency Management's Radiological Emergency Preparedness Unit (http://www.mil.state.ct.us/oem/radiolog.htm).

This page details the State's responsibilities for radiological preparedness. It provides links to the emergency planning booklet described above, potassium chloride information, and a link to the FEMA website. It does not however provide any link to the evacuation plans, or to any other resources about Millstone Station. The link to Millstone Station was inactive when this review was done.

The site also provides fact sheets on various topics, some of which are already contained in the booklet, including: evacuation routes, classification, evacuation checklists, host communities, sirens, take shelter checklists, and schools.

The only information contained in the fact sheet on evacuation routes for residents of Fishers Island is the following: "Persons on Fishers Island will go to Windham to obtain evacuation services. Transportation to the reception center will be provided." Again, no detail on the ferries or coordination of ferry operators is provided.

The Classification, Evaluation Checklist, Host Communities, Sirens, and Take Shelter Checklist fact sheets all contain information similar to that appearing in the planning booklet for residents.

The Schools Fact Sheet actually contains more detail than is listed in the booklet. For example, the superintendents and school principals know to follow specific procedures for the safe handling of school children, children will be accounted for and supervised at all times and at least one school official will accompany the children on the bus to the reception center. It also mentions that a copy of the current school roster, the day's absentee list and emergency parent or designee notification list will be brought to the host community reception center. This is important information that should be listed in the booklet and not just on the web site.

Suffolk County, the county in which Fishers Island is located, does not list any information about Millstone on their website and does not link to the Connecticut information. Although Connecticut is responsible for public education of New York residents, this lack of information should be addressed by Suffolk County. There was no information found on a Fishers Island website either. Again, Connecticut links to further information would help provide a more comprehensive public education and outreach process. This holds true for the New York State Emergency Management Office as well. Although there is information about radiological preparedness, no links or specific information or reference to Millstone or any other nuclear plant is given.

The website of Dominion Resources, the operator of Millstone, does link to the booklet. There is also information about environmental compliance and the Nuclear Energy Advisory Council for the plant. There are no links to the Connecticut's radiological information. This type of link would be helpful to cover all bases to ensure that people have access to all available information.

CHAPTER 6
REVIEW OF INDIAN POINT AND MILLSTONE TRAINING PROGRAMS

Training is an important component of the overall emergency management system. Once strategies are developed to protect people, a variety of personnel have to be trained. Training is necessary for personnel at Indian Point Energy Center, Millstone Power Station, and the emergency response personnel at the Counties and the State of New York. The Nuclear Regulatory Commission closely regulates and tracks the training program design, implementation, and feedback from training at both nuclear energy facilities. Training programs and records are scrutinized as a part of the Nuclear Regulatory Commission Inspection program and training is considered in the root cause analysis of any event or simulated exercise.

Training of civilian public agencies has historically been problematic across the United States. In case of a radiological emergency, for example, a wide variety of emergency responders would be expected to be involved in taking actions. Emergency managers at each of the five counties of Orange, Putnam, Rockland, Westchester, and Suffolk would be involved; the State Emergency Management Office would also be involved. The emergency management agencies at the county and state levels are engaged in emergency management full-time. The response would also involve a large number of other agencies: health departments, transportation departments, law enforcement agencies, school boards, etc. Many of these agencies have full-time, professional staff but are not engaged primarily in emergency management. Each of these agency's personnel has other responsibilities to fulfill. During routine operations (without an emergency), personnel from these departments can only attend to emergency management issues at brief intervals. Historically, it has been difficult to encourage personnel from these agencies to attend emergency management training.

Finally, there are a larger group of organizations that have a role to play in response. These include volunteer emergency personnel, transportation providers in the region, operators and owners of special facilities. Many of these organizations are private corporations. They must be convinced that there is a direct risk to them, and that the risk is significant enough, before they expend current resources to plan, train, and exercise for emergencies. Before September 11, 2001, it was very difficult to convince private corporations to engage in public training programs on specific hazards, such as radiation safety.

Training must be handled as an overall program. As discussed above, there are a cascading series of organizations that have a role to play in emergency response and recovery. Personnel serving important roles in response in each of these organizations need to have sufficient skills and knowledge to effectively complete their roles during a variety of potential events. Therefore, the first requirement of training programs is to know who needs to be trained, to perform what role, and the degree of skills and knowledge they must retain.

The Nuclear Regulatory Commission requires nuclear plants to define the Emergency Response Organization. The Emergency Response Organization includes all facility personnel that have a role to play during response. The Nuclear Regulatory Commission then regulates the training provided to these personnel, including their participation in drills and exercises. The Nuclear Regulatory Commission deems the actual demonstrated performance of these personnel as one of the key performance indicators of emergency preparedness. Performance indicators for Emergency Response Organization drill and exercise involvement have been published by the Nuclear Regulatory Commission for both Indian Point and Millstone.

Figure 6-1 below shows Emergency Response Organization drill participation thresholds for the two functioning Indian Point reactors; Indian Point 2 from the fourth first quarter of 1999 to the second quarter of 2002, and Indian Point 3 from the fourth quarter of 1999 to the second quarter of 2002. Both reactors on the Indian Point site have measured at above 90%. This means that over 90% of key emergency response organization members have participated in performance-enhancing drills, exercises, training, and events since the first quarter of 1999 (Indian Point 2) and the fourth quarter of 1999 (Indian Point 3).

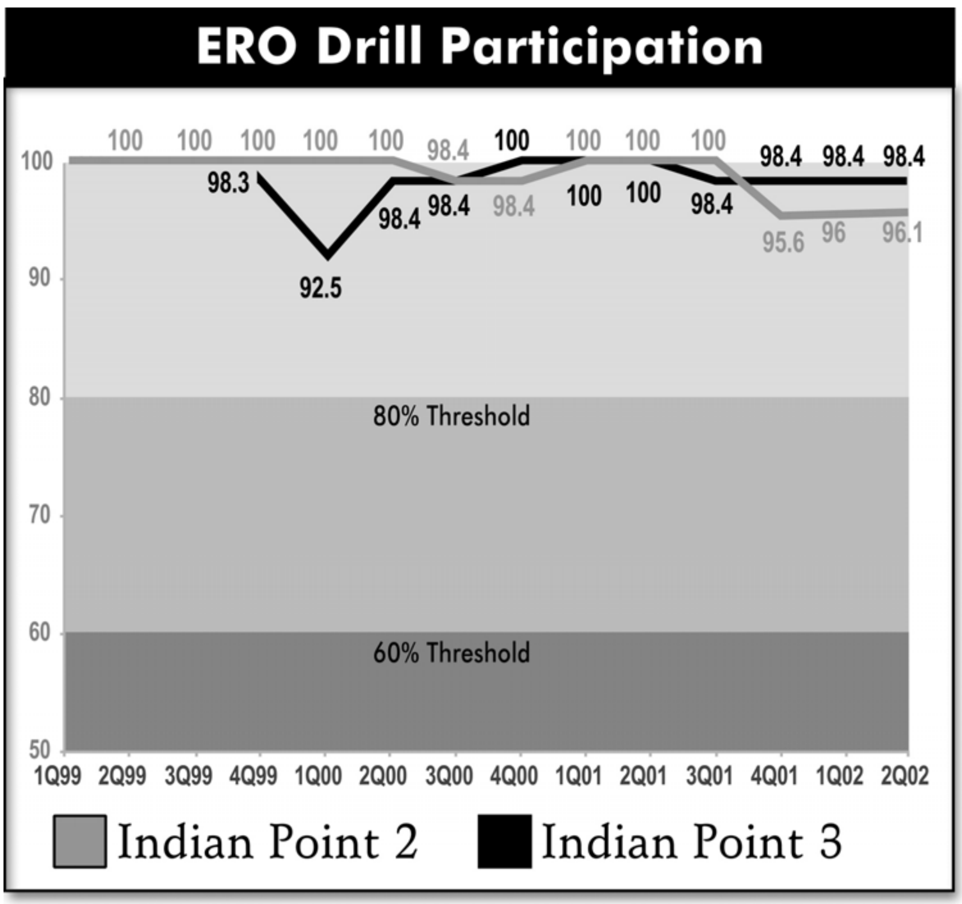

Figure 6-1: Indian Point Emergency Response Organization Drill Participation Thresholds

Figure 6-2 shows the equivalent Emergency Response Organization drill participation thresholds for Millstone 2 and 3 from the first quarter of 1999 to the first quarter of 2002 In this case the emergency response organization percentages are the same for both reactors at the site. As with Indian Point, the Millstone emergency response organizations have generally remained at above

90% participation, although the quarterly percentages are slightly lower than for the Indian Point reactors. The exception was the third quarter of the year 2000, when participation for the Millstone Emergency Response Organization dipped to nearly 81%.

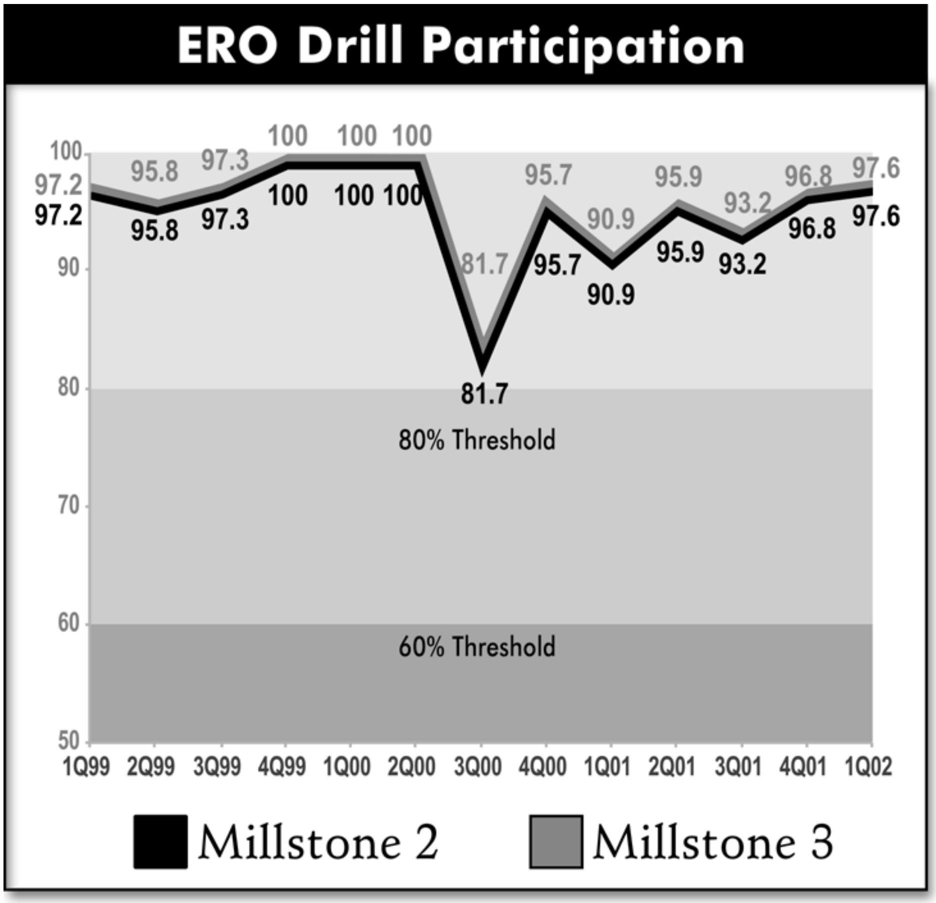

Figure 6-2: Millstone Emergency Response Organization Drill Participation Thresholds

The Nuclear Regulatory Commission also inspects the training program as a part of its overall oversight process. It reviews training lesson plans, personnel qualification records, and attendance sheets to make sure that members of the Emergency Response Organization are well trained to perform their responsibilities during any response.

There is no equivalent concept of an Emergency Response Organization on the public side of the fence. State and county plans identify many agencies that have a role to play in radiation response. However, these organizations are not defined as an Emergency Response Organization that must be cohesively trained. It must be pointed out that the Emergency Response Organizations at the Indian Point and Millstone facilities are staffed with utility employees and therefore can be required to attend training and maintain proficiency. Such control is generally not feasible in the State and county agency environment. Agencies other than emergency management have other missions that they routinely perform. Unfortunately, emergency management is burdensome and often treated as a discretionary requirement.

An example affecting the Fishers Island population underscores this point. Even though the ferry operation that services the island represents the link by which the island population would evacuate in an emergency, James Lee Witt Associates interviews with ferry personnel indicated they have not been specifically trained on a radiological emergency. Ferry personnel indicated they had not received training about the threat, the nuances of operating once there has been a public warning, or how the public would be expected to react. This is a significant observation given the planned mission of the ferry as related to a Fishers Island evacuation. The example also underscores the site-specific or local nature of some emergency preparedness needs. Plans and training for the area surrounding Indian Point may be very different than those for Millstone at the level of the localized preparedness issues. There is no "one size fits all" training plan. Training (and other preparedness activities) needs to deal with the specific local requirements. In a more general sense, training needs to focus on what will happen locally (e.g., what the population is expected to do when given an evacuation order) versus what emergency managers would like the population to do.

The Nuclear Regulatory Commission also requires that the nuclear energy facilities maintain qualification records for the members of the Emergency Response Organization. These records are audited by the Nuclear Regulatory Commission to ensure that each member of the Emergency Response Organization has been adequately trained and has recently enough demonstrated the skills and ability to perform their emergency functions. In reviewing training programs, the Nuclear Regulatory Commission considers that there may be a need for a protracted response. The Emergency Response Organization must be large enough to provide 24/7 staffing. All members of the Emergency Response Organization must be adequately trained.

At the county and state level, there does not appear to be an equivalent requirement for the maintenance of training records by individual or to ensure that individuals in specific positions have received requisite training. Two jurisdictions were able to produce training documentation. If such records existed at the other counties they were not readily produced for the evaluation. We reviewed training records from Westchester County and from the State of New York. These records indicate the courses taught, the dates of the courses, and the number of individuals that attended the training courses. Courses taught by Westchester County and the State of New York fall into the following categories:

- Basic Course on Radiation Emergencies;
- Radiation Monitoring (several courses);
- Emergency Action Levels;
- Dose Assessment (several courses);
- Emergency medical services and medical responses to radiological emergencies (several courses);
- Traffic Control Points.

In addition, the Indian Point utility provides training for the off-site agencies in radiological emergency management. Such training has been offered to fire departments, ambulance services, and hospitals. The James Lee Witt Associates team did not specifically collect this type of training information from Millstone.

The Nuclear Regulatory Commission has different mechanisms to establish whether or not training of licensee personnel, licensing examinations are required as a part of the overall preparedness capability of the plant. For the Emergency Response Organization staff, the licensee qualifies employees for the different positions, and reports qualification and re-qualification based on the individuals meeting specific criteria, such as participating in a minimum number of drills or exercises each year. This connection between drills and exercises and training is a very important one. An example will illustrate this issue. In February 2000, Indian Point had an event that was classified as an Alert. One of the problems found during response to this event was in the dissemination of public information. The Joint News Center is the facility from which public information is coordinated and released.

In response to this problem, Indian Point established a time commitment within which the Joint News Center would be activated. To speed the process of getting information out to the public, the emergency planning organization at the facility took the responsibility for activating the Joint News Center—rather than leave this function to the corporate office. Detailed procedures were developed for tasks to be performed by the Joint News Center. A formal training program was developed for the staff of the Joint News Center. Training was conducted and followed by seven drills between February and August 2000. These drills were to “improve performance and proficiency.”[122]

The drills were strongly critiqued and identified any noted problems in the performance of the task. Changes were made in the facility, organization and procedures for the Joint News Center based on these drill critiques. The Nuclear Regulatory Commission then inspected and reviewed the procedures to make sure that the changes to this part of the system did not degrade the overall effectiveness of the emergency planning at the facility.

This sequence of actions from the February 2000 event demonstrates the strong link between planning, training, and reviews (exercises, drills, inspections). Such a strong link is not evident when reviewing the counties and state training and exercise reports. Examples of public information shortcomings at the State of Connecticut in past exercises and school preparedness observations in past Indian Point exercises are indicators that potentially illustrate the differences in focus.

School preparedness has been demonstrated for several years using “bus runs” or interviews with school officials. In 2000, FEMA’s Indian Point full-scale exercise included drills for three schools in Rockland County. All three schools failed to “demonstrate the capability and resources necessary to implement protective actions for school children within the 10-mile emergency planning zone.” Officials at all three schools were provided with training. Before the end of November 2000, officials at all three schools indicated their familiarity with the emergency plans and procedures. The exercise report does not indicate whether this demonstration included drills to verify the ability of the schools to protect children. Interviews were conducted with school officials to correct previous problems. It is difficult to demonstrate improvement via discussion of what was done to improve. Evaluated drills can provide substantively better performance information and a better learning mechanism.

[122] NRC Inspection Report 05000247/2001-007, August 9, 2001.

A general training opportunity related to radiological emergency preparedness plan content was identified during the plan review and interview process. Knowledge about plan's associated components, such as implementing procedures, letters of agreement, call lists, etc., tends to be somewhat fractured within the organizations. Many times knowledge about plan components is limited to "the right person" being there. Emergency management staffs need to be able to map the "where" better, with more consistency across the operation. Training could be developed with that objective in mind. It is important that the organizations not consider this as simple as cross-training functions. This observation is really centered on the need to build core knowledge in the entire organization.

CHAPTER 8
REVIEW OF PREVIOUS INSPECTION AND EXERCISE REPORTS

Emergency response systems only come into play when there is an emergency or a simulated emergency. A comprehensive, realistic, and structured exercise program can show the effectiveness and adequacy of a community's emergency response system. In fact, an exercise program is necessary to determine the effectiveness of the emergency response system. Exercises are one of the important pieces of the system for protection of the public: plan, train, exercise, and ready (refer to Section 2.5 of this report).

A comprehensive and effective exercise program accomplishes a number of objectives. First and foremost, it measures the effectiveness of the emergency response system in the community. NUREG-0654 acknowledges this important objective of exercises when it states—"An exercise is an event that tests the integrated capability and a major portion of the basic elements existing within emergency preparedness plans and organizations" (page 71). It also provides feedback on where performance is not adequate and where improvements are necessary. An exercise program allows the individual players to learn their own roles in the context of the wider protection goals. It allows individuals and agencies to coordinate their actions and roles and to understand how the pieces fit together into the overall fabric of response. In addition, realistic exercises recreate some of the uncertainties and complexities of real events, forcing players to make decisions under stress. Real events create the same stresses but there is a severe penalty to pay for making the wrong decisions, not making decisions, or making decisions at the wrong time. Exercises also allow organizations to implement detailed procedures and test to see if they accomplish necessary objectives. It provides an opportunity to implement training. These objectives of exercises are also acknowledged by the United States General Accounting Office:

> Exercises test and validate policies and procedures, test the effectiveness of response capabilities, and increase the confidence and skill levels of personnel. Because a federal counterterrorist response is inherently interagency, agencies also exercise together. These interagency exercises enhance coordination among agencies and help them work together. They also allow personnel to become familiar with other agencies' procedures and identify those areas needing further coordination. In the absence of actual operations, exercises are an important indicator of the preparedness of federal agencies to deal with a variety of terrorist incidents.[128]

Finally, a well-thought-out exercise program shows where an emergency response system would hit its limits. There is a universe of hazardous events that any plan or response system can address, and beyond that universe, it will break. Exercises can show the scale of events that the response system can address and those that it will have trouble addressing. This information is crucial in knowing when outside resources will be absolutely necessary.

Since receiving their operating licenses, state and local governments and both nuclear energy facilities have participated in numerous exercises. In addition, the Nuclear Regulatory

[128] United States General Accounting Office: *Combating Terrorism: Analysis of Federal Counterterrorist Exercises* (1999), United States General Accounting Office/NSIAD-99-157BR

Commission inspects the Indian Point and Millstone plants regularly and issues inspection reports to note deficiencies. The sections that follow review the Indian Point and Millstone inspection and exercise reports and both facilities' self-reported performance indicators. It then addresses the exercises involving the counties and the states. Although previous exercise information was reviewed from both Indian Point and Millstone, there were more recommendations applicable to Indian Point, because there were more findings for Indian Point.

8.1 Analysis of Previous Indian Point and Millstone Inspection and Exercise Reports

NUREG-0654 requires that exercises and drills be conducted and evaluated and that deficiencies found in exercises be corrected. NUREG-0654 does not indicate how exercises should be evaluated. The Nuclear Regulatory Commission requires, plans, and conducts exercises to test facility preparedness. FEMA plans and conducts exercises to test state and local preparedness. The Nuclear Regulatory Commission also conducts routine inspections at the plants. In addition, it requires plants to self-report quarterly based on performance indicators established by the Nuclear Regulatory Commission. The Nuclear Regulatory Commission specifically uses inspection findings and performance indicators to determine plant performance. The initiative to combine inspection reports and performance indicators is relatively new, with implementation starting in April 2000.[129]

We completed a review of previous exercises, inspection reports, and utility self-reported performance indicators for Indian Point and Millstone in order to establish a baseline of previous performance information for the facility. It should be noted that Entergy Nuclear Northeast did not officially take over operations of Indian Point until September 6, 2001. FEMA and Nuclear Regulatory Commission reports for Indian Point were reviewed back to 1998, covering a period when Entergy Nuclear Northeast was not responsible for the plant.

8.1.1 Nuclear Regulatory Commission Inspection and Exercise Reports for Indian Point and Millstone

We reviewed a number of inspection and exercise reports for Indian Point from 1998 to present.[130] Inspection and exercise reports for Millstone from 1997 to present were also reviewed.[131] Appendices G and H distill the emergency preparedness relevant findings from these reports. Only findings relevant to response and recovery are noted. Mitigation actions related to plant performance during an event were not included in the analysis.

8.1.2 Self-Reported Performance Indicators for Emergency Preparedness

According to the Nuclear Regulatory Commission, the emergency preparedness indicators ensure that the plant licensee is "capable of implementing adequate measures to protect public

[129] Nuclear Energy Institute, "Regulatory Assessment Performance Guideline", NEI 99-02, Revision 2.
[130] Inspection and exercise reports were reviewed from: May 1998, June 1998, September 1999, May-June 2000, September 2000, January-February 2001, June 2001, October 2001, November 2001, March 2002 and May 2002.
[131]Inspection and exercise reports were reviewed from: August 1997, December 1997, April 2000, June 2000, January 2001, May 2001, November 2001, July 2002 .

health and safety during a radiological emergency,"[132] and they also help to determine whether the licensee has an effective emergency preparedness program.[133] It should be noted that there is a difference between implementation of adequate protection measures and the efficacy of the emergency preparedness program. Implementation of adequate measures for public protection is a performance issue, while program efficacy is directly related to the overall maturity of the emergency management system. The three performance indicators of emergency preparedness are:

- Alert and notification system reliability;
- Drill/exercise performance;
- Emergency response organization drill participation.

The indicators measure on-site performance for each facility (off-site performance measurements are determined by FEMA). The alert and notification system performance indicator has already been addressed in Section 5.3 of this report.

The drill/exercise performance indicator measures the facilities' personnel's execution of critical activities in emergency response:

- Event classification;
- Notification of off-site authorities;
- Protective action recommendation development.[134]

According to the Nuclear Regulatory Commission's explanation, the drill/exercise indicator measures "the percentage of all drill, exercise, and actual opportunities that were performed **timely** and **accurately** during the previous eight quarters." It is expressed as the percentage of timely and accurate performance of actions to total opportunities. The facility is measured each time it upgrades the emergency action level, each time it develops a protective action recommendation, and each time it sends out a protective action recommendation to the off-site counties and state. The measure also applies each time that such actions should be expected from the facility.

The Nuclear Regulatory Commission defines **timely** as:[135]

- Classifications need to be made within 15 minutes after plant parameters indicate a change in emergency action levels;
- Protective action recommendations are to be developed within 15 minutes after data is available to make such recommendations;
- Off-site notifications should be made within 15 minutes of event classification and/or protective action recommendation development.

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[132] http://www.nrc.gov//NRR/OVERSIGHT/ASSESS/cornerstone.html#EP
[133] NEI. *NEI Regulatory Assessment Performance Indicator Guideline, November 19, 2001*, NEI 99-02, Revision 0.
[134] NRC. *NRC Inspection Manual, Inspection Procedure 71114—Reactor Safety, Emergency Preparedness*.
[135] Nuclear Energy Institute, November 2001. Regulatory Assessment Performance Indicator Guideline. NEI 99-02, Revision 2.

The Nuclear Regulatory Commission defines **accurate** as:

- Accurate classification of event and protective action recommendation;
- The initial notification form completed is appropriate to the event.

The Emergency Response Organization drill participation indicator measures each facility's efforts to develop and maintain key emergency response organization skills. The indicator measures the percentage of key emergency response organization members who participated in drills, exercises, and events by quarter. "Key emergency response organization members" include Shift Manager and Shift Communicator in Control Room; Senior Manager, Key Operation Support, Key Radiological Controls, and Key Technical Support in Technical Support Center; Senior Manager, Key Protective Measures, and Key Communicator in Emergency Operations Facility; and the Key Operations Manger in Operational Support Center. Emergency Response Organization drill participation is credited only when contributions to drill/exercise performance are assessed.

The measurement is calculated by dividing the total number of key Emergency Response Organization members who participated in performance-enhancing drills, exercises, training, and events by the total key emergency response organization members. The Nuclear Regulatory Commission requires that 60% of key emergency response organization members participate in drills, exercises, training, and events, while a measurement of 80% or more is considered to be above regulatory requirements.

8.1.3 Analysis of Inspection and Exercise Reports and Performance Indicators

We analyzed the information from the Nuclear Regulatory Commission inspection and exercise reports against two issues:

- Ability to provide accurate, timely, and meaningful **warning to the public** on an event, including what protective actions should be taken;
- Ability to provide accurate, timely and meaningful **warning to personnel at the facility** and account for their whereabouts so that appropriate protective actions could be taken by the workers at the facility.

Figure 8-1 below shows a potential set of linked activities to provide warning to the public and warning to the workers at Indian Point. The actual flow of activities may differ to some degree from the depiction below.

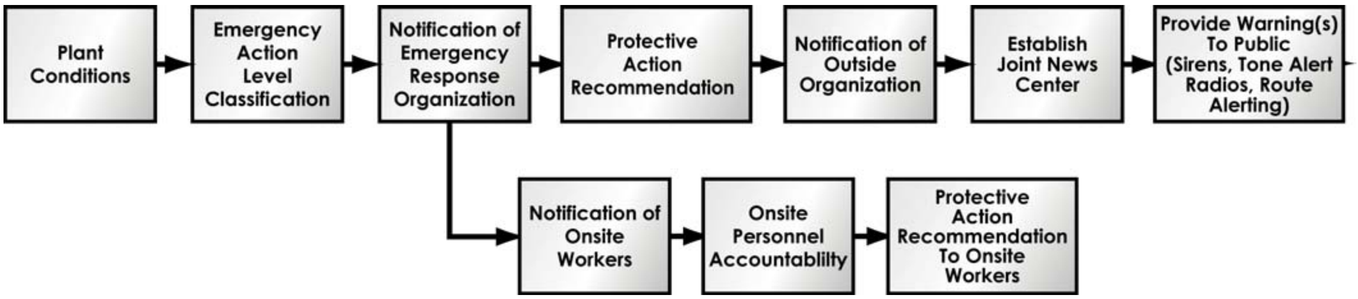

Figure 8-1: Potential Flow of Activities Leading to Warnings to the Public and Emergency Workers at Indian Point

Figure 8-2 shows drill/exercise performance measurements for Indian Point 2 and Indian Point 3 for the first quarter of 1999 to the second quarter of 2002 and the fourth quarter of 1999 to the second quarter of 2002, respectively. The drill/exercise performance thresholds figure includes some of the significant activities from Figure 8-1: classification of emergency level, development and communication of the protective action recommendation, and notification of off-site counties and state. The Nuclear Regulatory Commission requires that facilities respond in a timely and accurate manner to 70% or more of the total opportunities. If a facility responds to more than 90% of the total opportunities, the Nuclear Regulatory Commission designates that facility as having exceeded performance requirements. The performance measurement of Indian Point 2 has remained above 90% since the first quarter of the year 2000. The Indian Point 3 threshold measurement has remained above 90% since the fourth quarter of 1999.

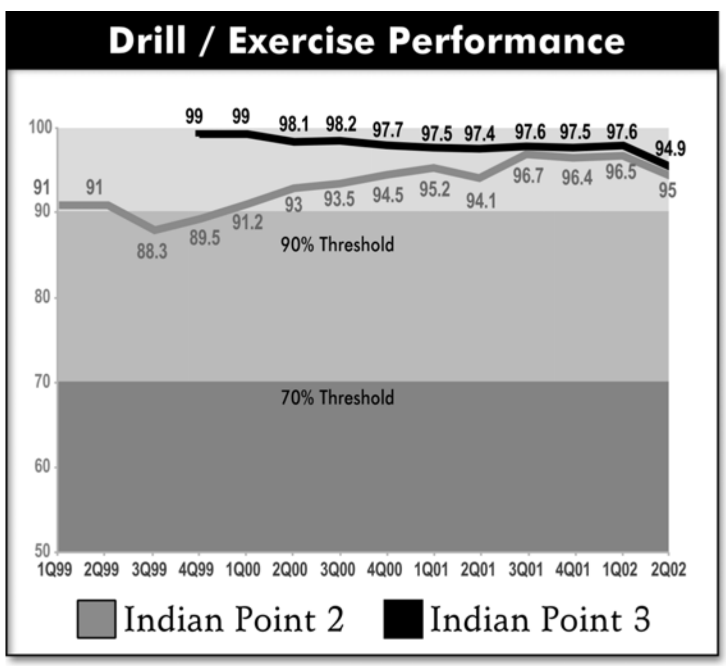

Figure 8-2: Indian Point Drill/Exercise Performance Thresholds

When reviewing the Nuclear Regulatory Commission inspection reports for Indian Point, a different set of issues from performance measurements emerge. Problems are evident in the

Notification of the Emergency Response Organization. Emergency Response Organization members are notified using pagers, and there was a problem with some of the pagers not activating in the June 1998 exercise. In February 2000, plant conditions led to a declaration of an Alert. The Technical Support Center personnel, who are part of the Emergency Response Organization, were not in place until 90 minutes after the Alert was declared. They are expected to be in place 60 minutes after the Alert status. The full Technical Support Center staff was not in place until 2 hours 51 minutes after the Alert was declared.

There have also been a number of problems with coordination of information with the county and state offices before a warning is issued to the public. The Joint News Center is an important coordination point for the release of public information. In the February 2000 event, the Joint News Center was not established until 2-2.5 hours after the Alert declaration.

When considering **On-Site Personnel Accountability**, there are a few problems. In an exercise in 1998, the accountability of Technical Support Center personnel was not maintained. In February 2000 during a real event, the site-wide accountability process took 138 minutes instead of the 30 minutes it should take. Again, in 2001, Operations Center personnel did not follow the accountability process. In March 2002, Indian Point personnel demonstrated the ability to complete site-wide accountability in 38 minutes. By May 2002, changes had been made to the personnel accountability process without prior approval of the Nuclear Regulatory Commission.

Figure **8-3** shows drill/exercise performance measurements for Millstone 2 and Millstone 3 for the first quarter of 1999 to the second quarter of 2002. Performance measurements for both Millstone reactors have remained at or above 90% during the documented period.

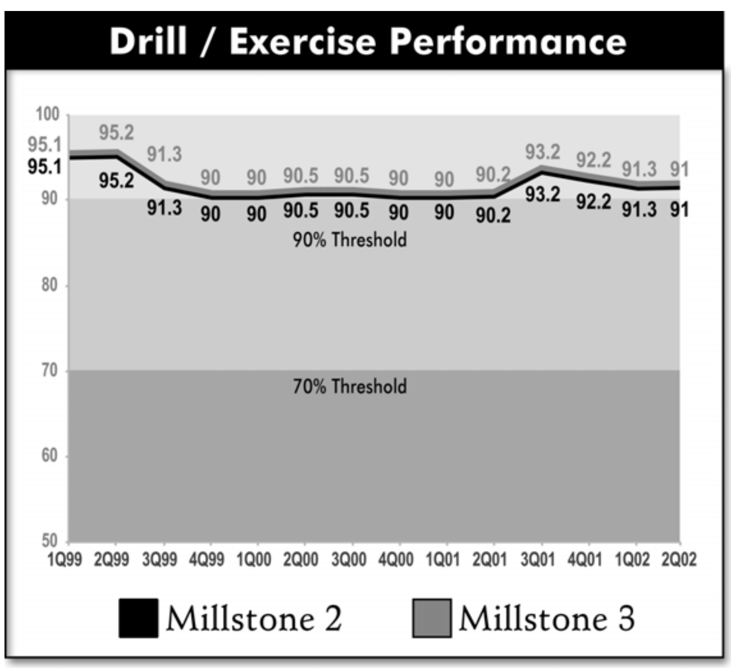

Figure 8-3: Millstone Drill/Exercise Performance Thresholds

When reviewing the Nuclear Regulatory Commission inspection and exercise Reports for Millstone, a problem is evident in the **Notification of the Emergency Response Organization**. In the inspection report for the period from August 12, 2001 to September 29, 2001, it was noted that the Emergency Notification Response System test data was not fully utilized to assess the Emergency Response Organization's capability to respond and activate the emergency response facilities within 60 minutes of event notification. There were many instances where the Emergency Response Organization personnel's estimated time of arrival, when added to the time they called into the Emergency Notification Response System, could have resulted in exceeding the 60 minute activation requirement. During the inspection, the inspector observed an unannounced communication test, in which the licensee took approximately 80 minutes to locate enough personnel to support initial activation.

8.1.4 Review of Off-site Exercise Reports

At least every two years, exercises are held simultaneously involving the facility, the State of New York, and the counties around Indian Point. A similar exercise process is observed for Millstone, including the State of Connecticut. Exercise planning starts one year prior to the actual exercise date. State and local agencies agree to exercise some or all of the functional objectives covered by the emergency response plan. The final agreements are laid out in the Extent-of-Play Agreements between FEMA and the state or county.

An exercise scenario is developed by the licensee in coordination with the off-site jurisdictions and is reviewed and approved by FEMA and the Nuclear Regulatory Commission at least 60 days before the exercise. The scenario details the accident that initiates exercise play. A cadre of evaluators arrives at the community prior to an exercise and receives training on site-specific issues. Exercises are normally conducted over a less than 12-hour period. A public meeting is generally held on the exercise one-to-two days after its completion.[136] A final report on the exercise is issued by FEMA about 190 days after it has taken place.

The historical record may often be of value in assessing future performance and capabilities. Therefore, reviewers were asked to look at the results of previous exercises and real events. We reviewed FEMA reports for Indian Point exercises that occurred in 2000, 1999, 1998, and 1996. The 1999 exercise report, which falls outside of the traditional every-even-year timeline for exercises, was based on the ingestion pathway emergency planning zone, which covers the 50-mile radius around the Indian Point facility. The 2000, 1998, and 1996 reports were based on the ten-mile plume exposure emergency planning zone around the nuclear facility. For the purposes of our historical review, the ten-mile emergency planning zone and exercise reports were comparable because the procedures followed by the 10-mile and 50-mile jurisdictions are similar. JLWA/IEM observers attended the September 5 practice exercise and September 24 full-scale exercise, and data and observations are given in Appendix I.

[136] The 2002 Indian Point full-scale exercise public meeting was held three days following the end of exercise.

In addition, we completed a historical performance review for Millstone and the New York jurisdictions within its ten-mile emergency planning zone. The historical review is based the last five years of FEMA-certified exercise reports.[137]

FEMA reports are arranged in an outline format that provides continuity among them. Each section includes a list of objectives, which are federal mandates that all jurisdictions must meet. The objectives are labeled as either met or not met in the reports. If the objective is not met, recommendations and corrective actions are generally listed, and the unmet objective is considered to be an Area Requiring Corrective Action or a Deficiency. The term "Deficiency" is a specific and significant term to designate a problem that is so severe that the facility must correct the problem or risk being shut-down.[138] An Area Requiring Corrective Action is defined as "an observed or identified inadequacy of organizational performance in an exercise that is not considered, by itself, to adversely impact public health and safety," according to FEMA-REP-14. During the historical review, we identified Areas Requiring Corrective Action as well as issues that could eventually lead to an Area Requiring Corrective Action or Deficiency designation, or worse—a system failure—but were not specifically labeled as Areas Requiring Corrective Action or Deficiencies.

The tables in Appendix G identify all of the Areas Requiring Corrective Action and significant issues identified in FEMA exercise reports and Nuclear Regulatory Commission inspection reports for Indian Point and its jurisdictions since 1996 and 1998, respectively. No Deficiencies were noted in these reports. The purposes of the tables are to identify historical Area Requiring Corrective Actions and significant issues and to make FEMA and Nuclear Regulatory Commission findings accessible for use in future exercises and reports.

According to NUREG-0654, an exercise is an event that "tests the integrated capability and a major portion of the basic elements existing within emergency preparedness plans and organizations." The federal exercise program takes this overall goal and breaks it down into 33 Functional Objectives. Each Functional Objective has associated Points of Review. Points of Review are questions or prompts for exercise evaluators. Exercise evaluators are expected to select "Yes," "No," "Not Applicable," or "Not Observed" against most Points of Review. The evaluators are required to judge whether the organization demonstrated performance consistent with NUREG-0654 and evaluation criteria. A common Point of Review for each of the Objectives is to make sure that all activities under the Objective demonstrated at the exercise were carried out in accordance with the state or local emergency response plan. The 33 exercise Objectives and associated Points of Review "…represent all capabilities needed by off-site response organizations to effectively respond to radiological emergencies at commercial nuclear power plants."[139]

For each Objective and Point of Review, a final grade is assigned. The possible grades are:

[137] IEM reviewed the following Federal Emergency Management Agency reports: *Exercise Report for Millstone Power Station*, July 31, 2002; *Final Exercise Report for Millstone Nuclear Power Station*, June 1, 2000; *Final Exercise Report for Millstone Nuclear Power Station*, December 23, 1997;.

[138] FEMA-REP-14, *Radiological Emergency Preparedness Exercise Manual* (September 2001), defines "Deficiency" as "an observed or identified inadequacy of organizational performance in an exercise that could cause a finding that offsite emergency preparedness is not adequate to provide reasonable assurance that appropriate protective measures can be taken in the event of a radiological emergency to protect the health and safety of the public living in the vicinity of a nuclear power plant."

[139] FEMA-REP-15, September 1991, *Radiological Emergency Preparedness Exercise Evaluation Methodology*.

D	Deficiency Assessed
A	Area Requiring Corrective Action (either from present exercise or from prior exercises)
M	Met (no Deficiency or Area Requiring Corrective Action is assessed, and there are no resolved areas requiring corrective action from prior exercises)
N	Not Demonstrated

Attributes of Good Exercise Programs

The United States General Accounting Office's 1999 publication, *Combating Terrorism: Analysis of Federal Counterterrorist Exercises*, quoted in the beginning of the chapter clearly describes the values of exercises as indicators of the preparedness of agencies at all levels.

Emergency exercise programs should have some specific characteristics, which are listed below:

- Exercise programs should measure the **effectiveness** of the emergency response system;
- Exercises should be **realistic**;
- Exercise evaluation should be **objective** and free from bias;
- Exercise programs should be **comprehensive**;
- Exercises and exercise programs should provide **feedback** for continuous improvements.

In the sections below, we evaluate the exercise program of both Indian Point and Millstone against these characteristics.

Indian Point and Millstone Exercises as an Indicator of Emergency Response Effectiveness

Assessing the effectiveness of the Indian Point and Millstone exercises is a complex issue which will be looked at in-depth in this section and the sections following. As a preliminary consideration, since 1996 for Indian Point and 1997 for Millstone, the exercises have resulted in no Deficiencies, although Indian Point has shown an upward trend in Areas Requiring Corrective Action. Figure 8-4 shows the number of Areas Requiring Corrective Action found at each of the Indian Point exercises since 1996.

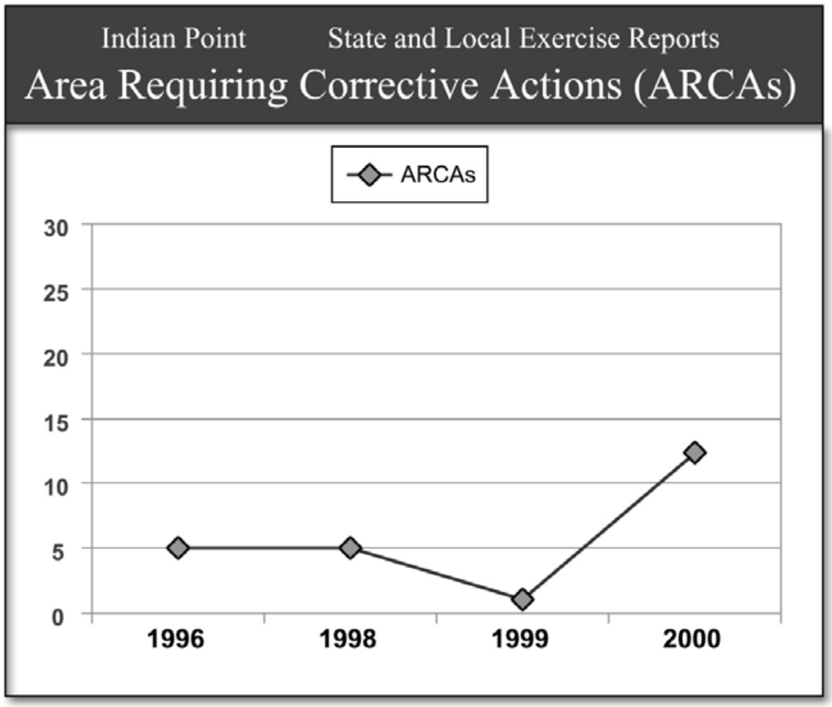

Figure 8-4: Areas Requiring Corrective Actions at Indian Point Exercises Since 1996

The large jump in areas found requiring corrective action should be of concern to Indian Point, state, and local officials since it is a *possible* indicator that the emergency response system may have become degraded in its capability to provide protection.

The number of Areas Requiring Corrective Action for Millstone has remained fairly constant throughout this examination period and is illustrated in Figure 8-5.

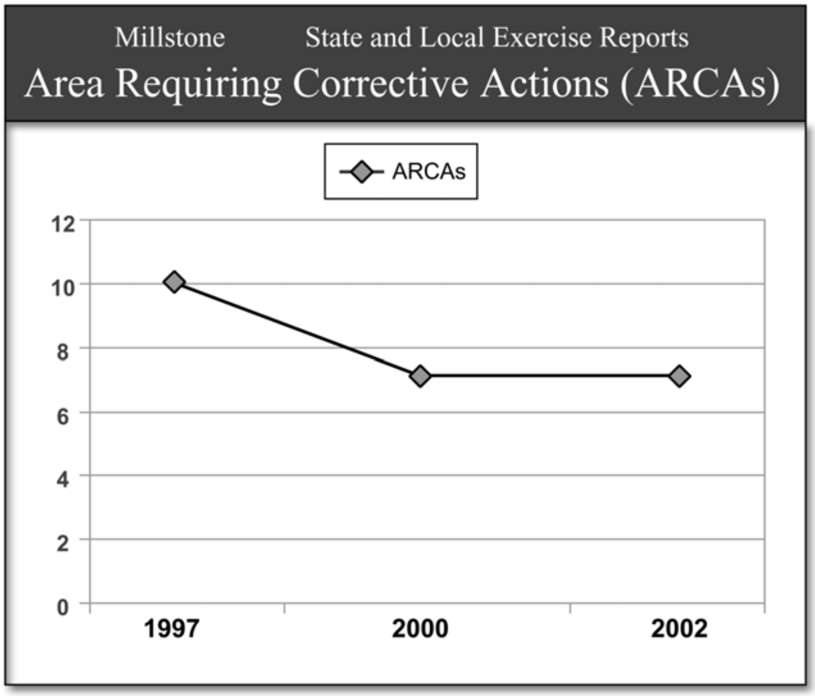

Figure 8-5: Areas Requiring Corrective Actions at Millstone Exercises Since 1997

School Preparedness

Indian Point

One of the important areas of preparedness is the protection of children. School preparedness and its assessment at Indian Point provide some valuable insights into how the exercise program functions. The Indian Point exercise report from 1996 does not provide enough detail to determine how school preparedness was evaluated. There were no Areas Requiring Corrective Action assessed against schools in the 1996 exercise. The counties of Orange, Putnam, Rockland, and Westchester demonstrated school preparedness through out-of-sequence bus runs and out-of-sequence interviews with school officials at selected schools. Out-of-sequence drills are routine practice in emergency preparedness exercises; "out-of-sequence" means that the activity is demonstrated at a different time from when it would be expected to occur during a real event.

The term "bus run" covers a variety of actions. For nuclear power plant exercises, "bus run" may refer to a simple interview with the bus driver or bus company executive. It may also cover a drill where buses are actually dispatched (without children) from the schools to the host locations. It may even involve a drill where school children are mobilized, a census is taken, and children actually board the bus. For liability reasons, children are usually not transported during an exercise to host locations. They board a bus, and then dismount and return back to classes, while the buses may continue to the host location. In the case of the Indian Point exercises, the bus runs seem to cover interviews with bus officials and perhaps some movement of empty buses to the host locations, except for one noted exception mentioned in the data for the year 2000 exercise.

In 1998, the same out-of-sequence bus runs and schools interviews were used to measure preparedness at Orange, Putnam, Rockland, and Westchester County schools. No Areas Requiring Corrective Action were noted for Objective 16: Implementation of Protective Action, Schools.

In 2000, Orange, Putnam, and Westchester Counties again demonstrated school preparedness through out-of-sequence bus runs and school interviews. No Areas Requiring Corrective Action were found for these three counties.

In Rockland County, a number of schools were exercised via an interview process with the school staff. These schools were not found to have any Areas Requiring Corrective Action. However, three schools in Rockland County were evaluated using out-of-sequence drills (drills conducted separately from the actual full-scale exercise day). Each of these schools failed to "demonstrate the capability and resources necessary to implement protective actions for school children within the ten-mile emergency planning zone." This is significant because it suggests that a preparedness weakness impacting a large number of children may not be identified unless an actual drill is conducted. Interviews focus on talking about what will happen and how effective the plans are. Drills involve the actual practice of the plan content. Whether or not the drill is in-sequence with or out-of-sequence from the full-scale exercise is not the issue. The realism with which the plan is tested is the issue. Observations derived from the actual on-the-ground practice cannot be "explained away" as they may be (if they even come to light) in an interview.

Did these problems not exist in earlier years and only emerged in 2000? It is not clear. Previous exercise reports for Indian Point indicate that school preparedness had been assessed through bus runs and interviews. This was the first instance that we found in reports from 1996, 1998, 1999, and 2000 where drills were used to assess preparedness.

It is important to note that the failure of the school drills did not constitute a Deficiency. The state and counties did appreciate the urgency and gravity of the problem. Officials at all three schools were provided with training. Before the end of November 2000, officials at all three schools indicated their familiarity with the emergency plans and procedures. The exercise report does not indicate whether this demonstration included drills to verify the ability of the schools to protect children. It appears that interviews may have been conducted with school officials to determine that the previously assessed Areas Requiring Corrective Action had been resolved.

In various sections of this report we compare Indian Point and Millstone to the Limerick, St. Lucie, and Surry nuclear power plants, because the plants are surrounded by similarly populated areas. The Limerick 2002 FEMA exercise report does not contain sufficient detail to assess how school preparedness was evaluated for most of the schools. One school district superintendent notified only one school in the district of the simulated emergency. He deemed it "not necessary to bother the other schools within the district for this exercise."

Interviews were conducted with school officials in St. Lucie and Martin Counties at the St. Lucie site. The St. Lucie 2002 FEMA exercise report lauds the efforts of the officials from Felix A. Williams and Jensen Beach Elementary Schools for "…their initiative and eagerness to participate outside the box and publicly exercise above and beyond by doing a physical, observed, but not evaluated, evacuation of the school children and staffs in an effort to ease the minds of parents and concerned citizens in the area."

For the 2001 exercise at Surry, school preparedness was assessed for two counties. One county (Isle of Wight) does not have any documented issues. Surry County "school personnel lacked familiarity with the Emergency Operations Plan."[140] The report does not indicate how school preparedness was assessed at Isle of Wight or at Surry County schools (out-of-sequence bus runs, interviews, drills, or other means). Also, in Surry County, school children were released at 11:45 am, but the press release did not go out to the public until more than an hour later, at 12:55 pm.

During the 2002 exercise, JLWA/IEM observers noted that the default practice at Westchester County for schools that are not being evacuated is to wait for regular dismissal time to release students, even in the event of an emergency. The decision in Westchester County was made for all schools not currently in an evacuation-recommended zone to dismiss at normal dismissal time. Commuter rail service into these areas had been suspended already. The commuter rail suspension would prevent many parents from reaching their homes. There was no discussion observed about elementary or middle school children being sent home to houses without guardians, although a school representative told an IEM observer upon questioning that schools would only send children home to places where a caregiver was present. It is not known how the school system would determine such presence, although JLWA interviews revealed that bus supervisor(s) were convinced that a bus driver would know if a caregiver was present. Less than one hour after the children were simulated to have been returned home, the same zones were advised to evacuate. Many of the children presumably left home alone would not be able to evacuate themselves. This and closely related problems have been termed "the latch key kids" problem.

The potential for congestion on the roadways due to shadow evacuation was not observed to be a topic of discussion at any of the off-site Emergency Operations Centers (in Westchester County an hour was added to the ETEs to account of the age of the data, not shadow evacuation). "Shadow" evacuation is a phenomenon that has been well-studied since the Three Mile Island evacuation in 1979. Yet, the exercise did not stress the system by forcing this issue to be faced.

JLWA/IEM observers did not note any of the Emergency Operations Centers soliciting and integrating traffic information from their law enforcement personnel on actual traffic congestion in the community.

There was an exercise event, caused by a message injected into the play, in which parents caused congestion at two of the schools in Westchester County. The county responded by sending officers to the two schools, but there was no observed attempt to determine if other schools were having similar problems. A report simply came back to the County Emergency Operations Center that the traffic congestion was taken care of. In real events it is important for officials to proactively seek out problem areas before they become major and/or impact other areas of

[140] A county bus driver also lacked knowledge of radiological exposure control.

operation. Sometimes those on the scene are reluctant to report problems, for a variety of reasons.

Millstone

The May 2002 exercise at Millstone included an out of-sequence school demonstration at Fishers Island School. There was little detail regarding this demonstration in the Exercise Report, except that the Superintendents of all participating schools (including Fishers Island) were interviewed and were well aware of the importance of their responsibilities of protecting the school children as early as possible, and that they were knowledgeable of their plans and procedures. However, in the Millstone Nuclear Power Station Fisher Island Emergency Operations Center Narrative Exercise Evaluation, May 2002, the Superintendent of the Fishers Island School District expressed reservations about the adequacy of the evacuation plan. There was no Area Requiring Corrective Action identified, but it is noted in the extent of play section of the exercise report there was no vehicle demonstration for Fishers Island since school evacuees walk to the Fishers Island ferry and control of evacuees is transferred to the State once the ferry docks in Connecticut.

Responding to Information Needs: Public Information and the Media

Indian Point

Another important emergency response effectiveness issue is one of providing adequate, timely, and coordinated information to the public and to the media. Every emergency creates an urgent and overwhelming demand for information, from officials at all levels of government, from media around the world and from the public. How does the Indian Point exercise program test the ability to provide accurate, timely, and coordinated information to the public and to the media? The answer to this question is an important component of an assessment of response plan effectiveness.

In 1996, the Indian Point exercise indicated a problem with the location selected for the Joint News Center. The Joint News Center had problems with ventilation and limited air-conditioning. This caused one worker to be sent to the hospital in an ambulance. Eventually, the Westchester County Commissioner of Health shut down the facility. This problem was later corrected by installing air conditioning units.

During the 1998 exercise, no problems were reported with providing information to the public. During the 1999 ingestion pathway exercise, the State of New York had to develop and communicate the relocation and re-entry plans. The state did not fully coordinate the plans with other organizations, including the counties. The state also did not properly communicate the plans to the public.

In the 2000 exercise, the state and county Public Information Officers were at the Joint News Center. They sent out Emergency Alert System messages with accurate information on what the public should do. However, they did not send backup information with expanded public information on actions the public should take to protect itself. Also, the rumor control number was not included in any of the brochures and public information distributed prior to the exercise. The rumor control number was also not included in the messages sent to the public during the exercise.

The Joint News Center held a press briefing a few minutes before the public received its first siren and Emergency Alert System message indicating something was amiss at Indian Point and they should "stay tuned." The second media briefing was held at the same time that the public was being alerted and notified by sirens and Emergency Alert System that they should either evacuate or shelter.

Reviews of recent exercise reports from the Limerick, St. Lucie, and Surry plants indicate similar problems at one location with providing information to the media and to the public. Limerick (2002) and St. Lucie (2001) exercise reports do not show any problems with communicating information to the public.

During the 2001 Surry exercise, Surry County received a negative rating for public information: "Press releases and the press briefing contained inaccurate, incomplete, conflicting information and were not timely in their issuance." The press releases told the public to shelter and that no protective action was required. The report concludes "The general public would not have a clear understanding of what was occurring."[141] These problems occurred despite the fact that pre-scripted news releases were available for the "anticipated" event.

Sharing information with the media has been an issue in a number of recent exercises and disasters. The International Atomic Energy Agency's INEX series of nuclear exercises noted the difficulties with such information sharing. French nuclear exercises attempt to model the stresses of the convergence of media at a disaster site by including real media personnel in simulated press briefings.

Millstone

Exercises for Millstone in 1997 and 2000 indicated some problems with the Joint Media Center regarding unclear messages, status board updates, and misuse of terminology. These problems included poor coordination of the spokespersons prior to news briefings resulting in inaccurate information being released to the public. However, the problems appear to have been corrected by the 2002 exercise. It is noted that the Joint Media Center staff demonstrated a coordinated partnership with the State Emergency Operations Center staff, Governor's press staff, and Millstone Power Station representatives. The press advisories, news releases, and fact sheets were noted to be well written in simple, clear language.

Hazard Information Communication: Understanding What Happened

The first step in protection of the public is to assess the accident that has occurred. This involves estimating the type and amount of release and the resulting expected doses to the public. NUREG-0654 states categorically that the purpose of the emergency response system is to reduce the doses to the public: "The overall objective of emergency response plans is to provide dose savings for a spectrum of accidents that could produce off-site doses in excess of protective action guides." Given that stated objective, it should be of great importance to predict when and where doses in excess of protective action guides may occur based on plant conditions.

[141] Surry 2001 Exercise Report, Page 44.

The Indian Point facility takes plant parameters and estimates the likely accident that might result. These parameters are then used to judge the extent of the accident and to develop recommendations to protect individuals. These recommendations and the hazard assessment on which they are based are shared with off-site jurisdictions.

The Indian Point exercise reports in 1996, 1998, and 1999 did not indicate any problems with sharing dose assessment and protective action recommendation information. However, in 2000, the State Emergency Operations Center received an Area Requiring Corrective Action for an inoperable data system responsible for providing detailed information on plant status information and plume projections.

The utility supplied the State of New York with a Meteorology Information and Dose Assessment System ("MIDAS"). This consisted of a computer terminal and printer. Information on the plant status and projected plume data was expected to be shared between the utility and the state using this system. The data transfer was to occur automatically every 15 minutes. The state would simply have to print the received data and quickly have access to updated plume projections. However, the printer had problems printing the received data. Also, the data provided over MIDAS did not match the information faxed by the utility to the state. This problem was logged during the November 2000 exercise. In the first quarter of 2001, a test was conducted at Indian Point. The system was still inoperable. The data system was finally operable in a test conducted during the Nuclear Regulatory Commission inspection from January 16 to February 9, 2001, at the Indian Point plant.

The operable data system appears to be the combination of the Meteorological, Radiological, and Plant Data Acquisition System (MRPDAS) and the Modular Emergency Assessment and Notification System (MEANS). The MEANS in particular uses input from the MRPDAS and data from the 21 standard plume overlays developed for Indian Point in the 1970s. The overlays can not dynamically accommodate wind shifts. If there is a wind shift, another overlay is used. This is not a scientifically conservative approach. If there is a wind shift, the radiation would cover the area from the initial wind direction to the eventual wind direction. The radiation would not cleanly move from one wind direction to another.

Neither the utility nor the off-site agencies use a computer system that shows the time-sequenced spread of radiation, integrated with population and evacuation route information. Such systems are relatively common and should be an integral part of the response system and of exercises. The INEX series of international nuclear exercises emphasized the use of information technology in sharing volumes of hazard information quickly and effectively across countries.

Moreover, the meteorological data used to calculate the dispersion of radioactive materials at Indian Point is scant. After the Oklahoma City Bombing, Governor Frank Keating's after-action report noted the problems with lack of accurate and timely weather information. The report called for the implementation of a weather information system to be used at disaster scenes. The concern at the Oklahoma City disaster was with falling debris from structurally unsound buildings. But, in a nuclear accident scenario, the need for comprehensive and timely information is much greater. The primary hazard is radiation and the dosage received by people is very dependent on meteorological conditions.

During the September 11, 2001 response and recovery efforts, there was an urgent need for accurate and local weather data. The National Weather Service was able to locate a privately owned meteorological tower in the vicinity of the World Trade Center towers and was able to draw weather data from this tower. It may not be possible to locate enough meteorological towers around all critical structures. However, with the added emphasis on nuclear power plant safety, it is important to have access and use of sufficient, localized weather data.

We contrasted this with the use of technology in security for nuclear power plants. Mark Findlay[142] testified on April 11, 2002, to the House Subcommittee on Oversight and Investigations. He reported that nuclear power plants use sophisticated detection systems, including hand geometry recognition and explosive sensors, and since September 11, the facilities have started to acquire electronic fingerprinting equipment to perform rapid analysis of fingerprint data.

A succession of technologies has been and continues to be introduced at other layers of safety assurance, but the emergency response system is still tied to standard overlays developed 25 to 30 years ago that directly influence the dose assessment. Because the exercises show no calculation of people potentially effected, and avoided doses, there can be no demonstration of progress over time in reducing the numbers of those affected and/or in reducing the doses received. Thus previous exercises, and the September, 2002 FSE in which FEMA's revised methodology was used, do not demonstrate the effectiveness of the emergency response system in protecting health and safety.

[142] Mark Findlay is the Director of Security for NMC, LLC, which is the company responsible for safety at six nuclear plants.

Indian Point and Millstone Local Jurisdiction Notification

Since the counties of Putnam, Orange, Rockland, and Westchester receive notification at the same time via the Radiological Emergency Communications System ("RECS"), the notification times are equivalent for all counties involved in an exercise. The following graphs show how long it took for RECS call to be initiated after an emergency classification level was determined or changed by the Indian Point Emergency Director. The facility is required to notify the counties within 15 minutes any time there is a change in the emergency classification level.

Figure 8-6 below shows that during the 2002 Indian Point full-scale exercise, it took longer than usual for the Emergency Operations Facility to notify the counties that an alert had been declared by the Executive Director. It also shows that during this year's exercise, it took less time than usual for the Emergency Operations Facility to notify the counties upon declaration of a Site Area Emergency. In addition, the figure shows that it took less time than usual for the Emergency Operations Facility to notify the counties of a General Emergency declaration.

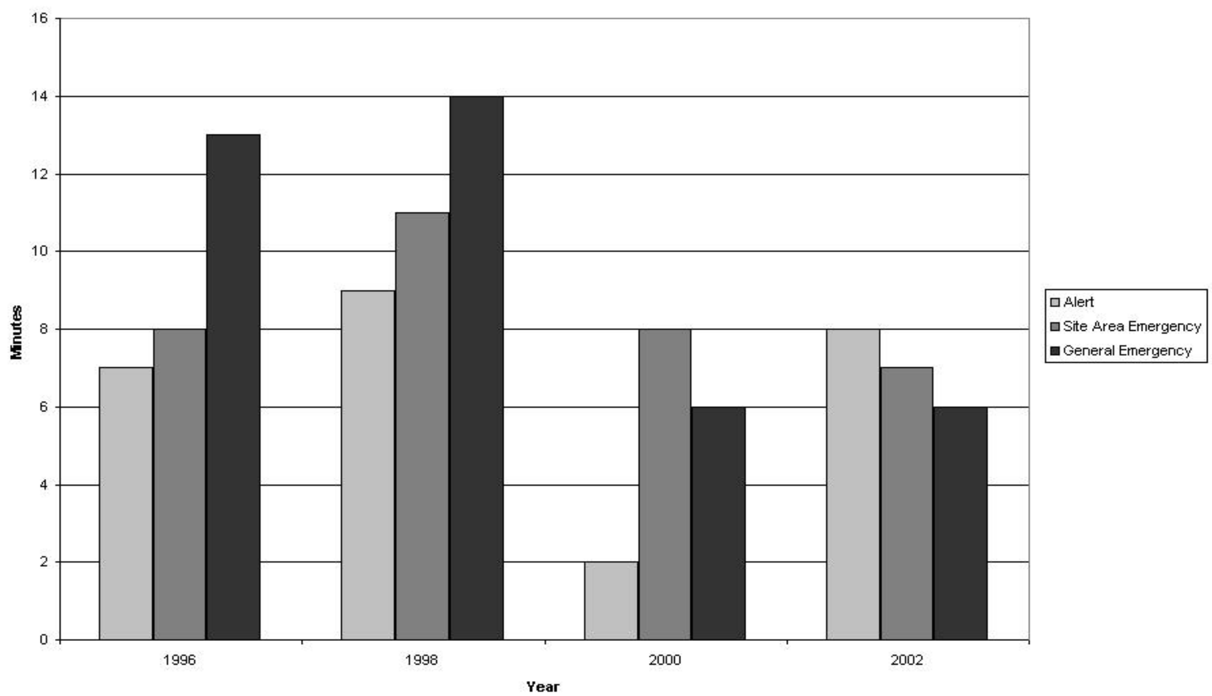

Figure 8-6: Time for the Indian Point Emergency Operations Facility to Notify Counties after a Classification Level Change

Figure 8-7 below shows the time required for the Millstone Emergency Operations Facility to notify Fishers Island after a classification level change.

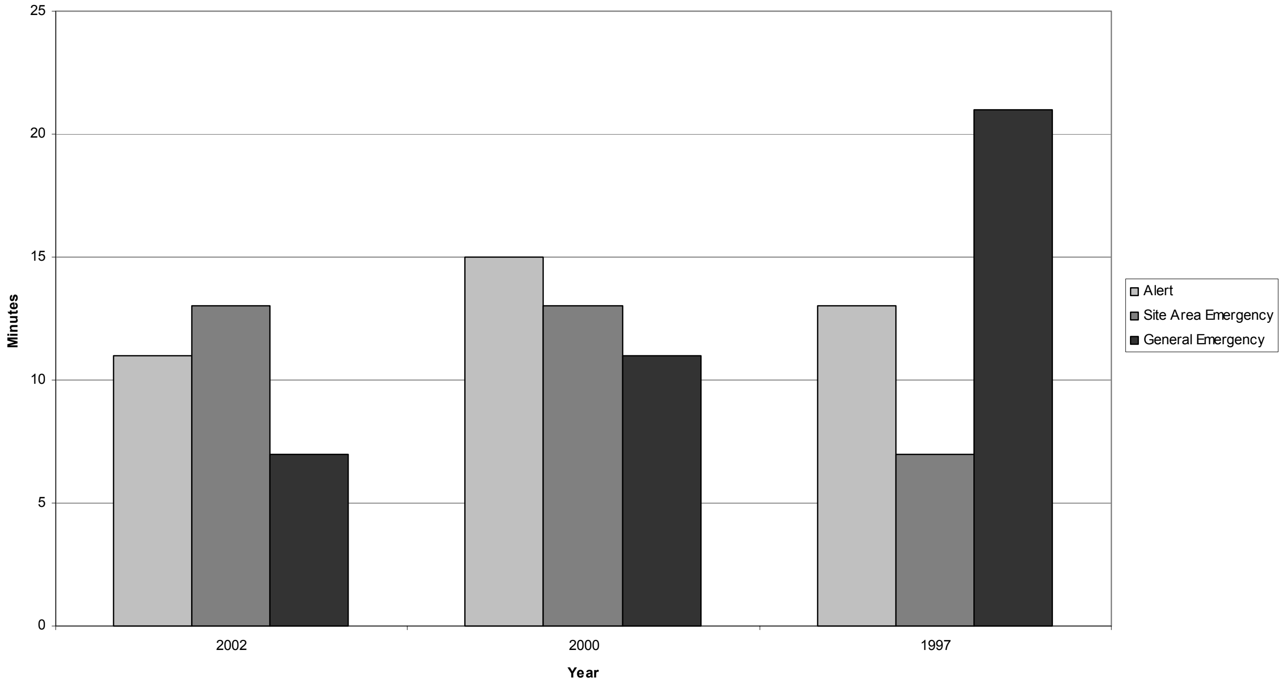

Figure 8-7: Time for the Millstone Emergency Operations Facility to Notify Fishers Island after a Classification Level Change

Indian Point Public Alert and Notification

Once the counties have been notified in a full-scale exercise that the Indian Point has declared an Alert, the counties must take measures to notify the public. The speed at which this information is relayed to the public can have a large bearing on the effectiveness of any protective action. This is especially important because of the relationship between the amount of time the public has to protect itself and the level of protection achieved during an emergency. For example, if the public has 10 minutes to protect itself based on the notification time of the incident, there may not be time to implement the directed protective action (e.g., evacuation or sheltering) while if there are several hours, this might allow the public to follow instructions to the fullest. An extreme case would be if the hazard actually arrived in a populated area before that population was even notified.

Once a protective action decision is made, the next step is to disseminate that information to the public. This is done through the combined use of siren and Emergency Alert System alert and notification systems. Figure 8-8 shows how long it took for the counties to notify the public after they were notified of the Indian Point Alert status in the last four exercises. In all exercises, the majority of the time is spent making a protective action decision. This time also shows an increasing trend through the past four exercises.[143]

[143] A possible explanation is that in 1996 and 1998 the facility declared an Unusual Event before declaring Alert, while in 2000 and 2002, the facility initially declared Alert. There is not enough data in the exercise reports to confirm this or other possible causes.

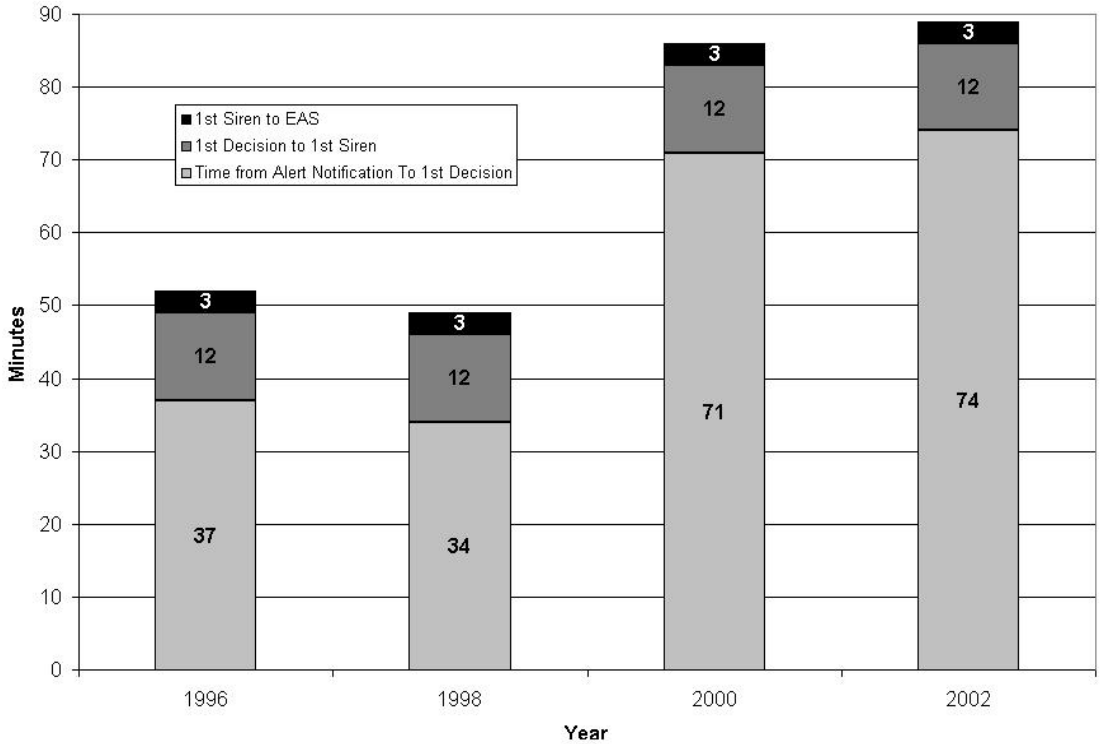

Figure 8-8: Time to Initial Public Notification after Counties were Notified of Alert for Indian Point Exercises

It should be noted that the time between the initial protective action decision and the first siren is always exactly twelve minutes. This may be because there is a standard that must be met—of protective action decision to activation of 15 minutes and there is a three-minute lag between the siren activation and the start of the Emergency Alert System message. The data suggests that participants may be using the entire 15 minute window, rather than informing the public as soon as possible.

8.1.4.1 Indian Point and Millstone Exercises and Realism

Exercises should be as realistic as possible. Emergencies are characterized by uncertainty, surprise, and unexpected events. No emergency displays an orderly process exactly as postulated in planning. It is important to portray the same mix of the unexpected, uncertain and incomplete information, and unique issues.

The realism in exercises can be interjected through a variety of means. Exercise scenarios can be varied, causing participants to be uncertain about what has happened at the plant and what may happen subsequently. Exercises can be no-notice, causing emergency personnel to mobilize suddenly as they would for a real emergency. Exercise events (injects) can introduce new issues that may present themselves in real events. Real systems and facilities should be used in exercises to see the effect of these on protection of people. An increasingly complex part of emergency preparedness has been the overwhelming need and appetite for information from the public and the media. The persistent and probing questions from the media can be integrated into exercise play. These, and more measures, can increase the sense of realism and stress emergency responders and simulate real event conditions.

Accident Scenarios

Figure 8-9 below shows how accident scenario progressed from Unusual Event, to Alert, to Site Area Emergency, and finally, to General Emergency at the 1996, 1998, 1999, 2000, and 2002 Indian Point exercises.

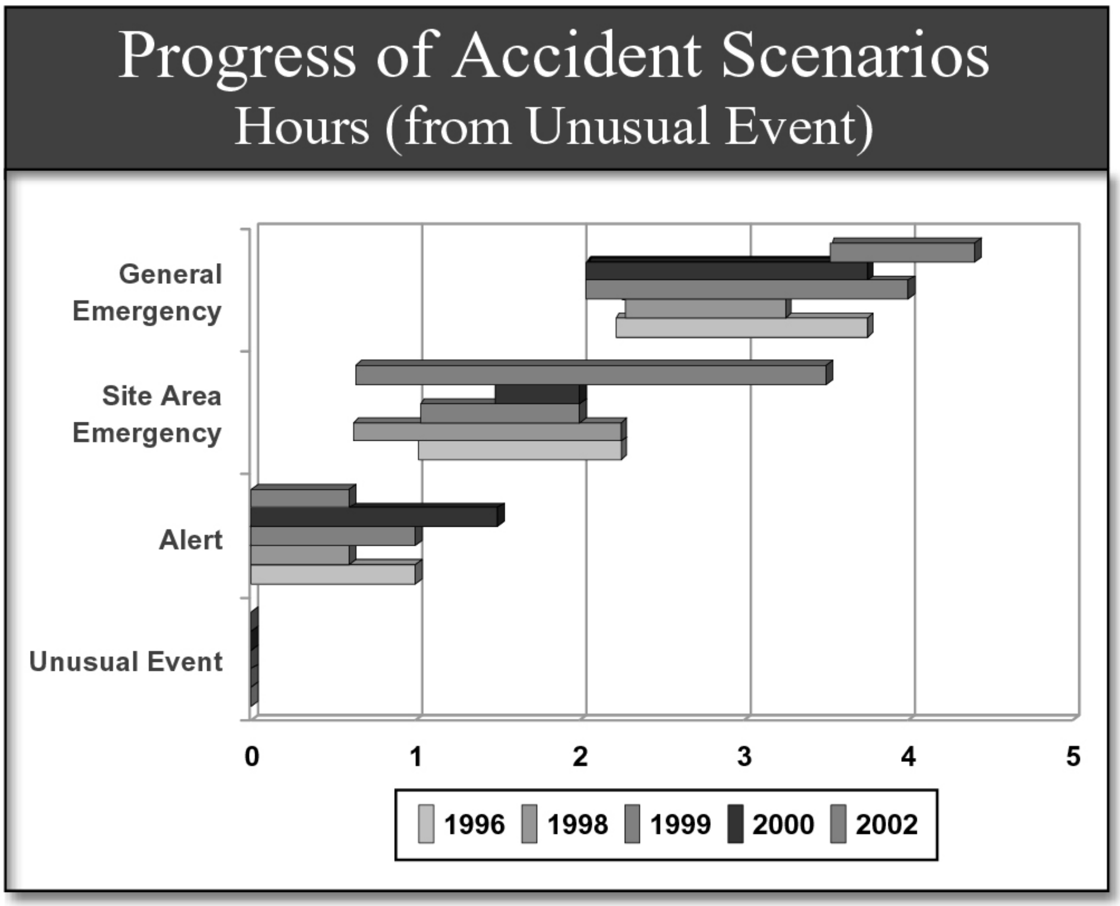

Figure 8-9: Progress of Indian Point Accident Scenarios in Hours

All accident scenarios in the 1996, 1998, 1999, and 2000 exercises have followed the same pattern—there is a roughly one-hour time span between escalations of the event scenario. A similar pattern is observed for the Millstone exercises from 1997 to 2002. This "tempo" can be known to participants and therefore reduces the uncertainty that emergency personnel would suffer during a real event. In fact, a few actions by emergency personnel indicate that they are aware of this narrowly defined accident tempo. During the 2000 Indian Point exercise, FEMA reports indicate that a Westchester county Public Information Officer announced at a media briefing that sirens had been sounded at 10:39 am, and an Emergency Alert System message had been broadcast at 10:44 am. Unfortunately, this message was released at 10:35 am, prior to the time that these events would have occurred. Participants in the exercise seemed to be leaning far forward and anticipating actions that had not yet occurred. If the information in the FEMA report is accurate, it would indicate that the exercises are so predictable that their efficacy could be called into question. Another possible explanation would be that an individual involved in the exercise could have been provided information about the exercise prior to the commencement of the exercise. Any of these cases negatively affect the ability to assess response effectiveness.

Terrorist incidents have the potential to cause immediate escalation to a Site Area Emergency or General Emergency.

No-Notice Exercises

Most exercises at Indian Point and Millstone are planned about one year in advance. Participants know when an exercise is to occur. Participants have a chance to refresh their knowledge of plans and procedures, review checklists, examine and repair equipment, and prepare psychologically for the exercise. But, nowhere is the difference between a no-notice exercise and a planned exercise more apparent than on the notification and mobilization of personnel for the event.

In a review of over 200 federal counter-terrorism exercises conducted in the three years since 1995, the United States General Accounting Office found only four exercises that were no-notice.[144] Three of these were conducted by the Department of Defense, and one was conducted by the Department of Energy. The Department of Defense conducted its Eligible Receiver Series of no-notice full-scale exercises to test the vulnerability of the nation's critical infrastructure against attack.

Since then, there is indication of a small rise in no-notice exercises. The Memphis Shelby County Airport Authority held a no-notice full-scale airplane disaster exercise. The Centers for Disease Control and the City of Louisville, Kentucky, held a no-notice exercise for bio-terrorism events on August 17, 2001. The Senate Appropriations Committee mandated in 1999 that the Department of Justice conduct no-notice exercises to test the nation's capability to combat terrorism.[145]

NUREG-0654, the regulation that defines emergency planning for nuclear sites, recommends, "some exercises should be unannounced." However, there is no indication that unannounced exercises have been held at Indian Point or Millstone during the years covered by our review (since 1996 for Indian Point and 1997 for Millstone.

8.1.4.2 Indian Point and Millstone Exercises and Comprehensiveness

Exercises should cover a variety of conditions. Events can vary along a number of dimensions—weather, accident/source term, time of event, road congestion at time of event, availability of major road systems, population distribution, etc. A comprehensive exercise program should vary these conditions to test the ability to protect people under these varying circumstances. Three of

[144] United States General Accounting Office, June 1999.
[145] Cited in General Accounting Office, June 1999.

these issues are addressed below: exercises during non-duty hours, exercises involving terrorism scenarios, and exercises for varying types of accident events.

Non-Duty Hours Exercise

NUREG-0654 states that "Each organization should make provisions to start an exercise between 6:00 pm and 6:00 am once every six years." In the seven years since 1996, none of the federally evaluated exercises for Indian Point have started after 6:00 pm. The exercises at Limerick, St. Lucie and Surry also started during the morning or afternoon hours. The 1999 ingestion pathway exercise started in the afternoon, but not after 6:00 pm. In addition, none of the federally evaluated exercises for Millstone have started after 6:00 pm.[146] In our experience with other county emergency management agencies, non-duty hours increase the length of time taken to perform critical tasks, such as making a protective action decision and warning the public. Time spent may increase by as much as 200% or more over the time to respond during duty hours. In addition, related issues such as the capability to contact key personnel can be evaluated during non-duty-hours exercising.

Terrorism Scenarios

The International Atomic Energy Agency, the international equivalent to the Nuclear Regulatory Commission, acknowledged in a meeting held after September 11, 2001, that nuclear power plants pose attractive targets to terrorists because of the potential to create a "spectacular attack." These attacks may be airplanes striking the reactor to trucks using conventional explosives against nuclear reactors. According to International Atomic Energy Agency's November 11, 2001 publication, *Nuclear Terrorism: Reactors and Radiological Attacks After September 11*:

> Most of the world's 440 nuclear power reactors would be highly vulnerable to a similar attack to those launched on September 11: a passenger aircraft laden with fuel being crashed into the building. The impact and fire caused by such an attack would likely compromise the containment system that surrounds reactors, increasing the risk of a radioactive leak. Many containment facilities are designed to withstand the impact of a small plane: the concrete dome may be 3 feet thick and heavily reinforced by steel, with a 1 inch to 4 inch lining, also made of steel. There may be further two concrete walls near the reactor vessel, each one foot thick and reinforced with steel bars. The reactor vessel is itself made of high-carbon steel, about 4 to 6 inches thick. In the United States, reactors are designed to withstand both earthquakes and hurricanes. This might or might not be enough to prevent the reactor vessel itself being broken open by a plane crashing into the facility. The exact nature of the damage caused by such an attack would depend on the size of the plane, amount of fuel it carried, speed and angle of attack. Although the emergency coolant system would ordinarily prevent an explosion, it is possible that both primary and back-up systems could be severely compromised by such an attack, possibly leading to a steam explosion at a reactor.

The Nuclear Regulatory Commission has not concurred with these potential effects of an airplane strike on a nuclear reactor. The Nuclear Regulatory Commission is preparing a study on the effects of terrorism incidents on nuclear reactors. The review is being performed in association with Sandia National Laboratory. Richard A. Meserve, Chairman of the Nuclear Regulatory Commission, while testifying before the House Subcommittee on Oversight and

[146] There is no information that on any starting times for the out-of-sequence October 8-10, 1997, Ingestion Pathway Exercise. There is no indication that they began after 6:00 p.m.

Investigations on April 11, 2002, said “Before September 11, 2001, nuclear power plants were among the best defended and most hardened facilities of the Nation's critical infrastructure.”

Terrorist events could take other forms, such as trucks armed with conventional explosives. Each of these potential terrorist acts carries the implication of a change in the nature of the scenario under which emergency organization must respond. An immediate crises and release from a nuclear reactor would require quick action on the part of the facility and off-site emergency response organizations to adequately protect vulnerable populations.

The French government instituted a circular in March 2000 that requires the ability to take rapid actions for fast-evolving accidents. The French government defines “fast-evolving accident” as an event with a potential to cause radiological consequences to the population in less than six hours.[147] It is not clear whether the Indian Point exercise program has exercised such scenarios with sufficient levels of participation by REP organizations in the last seven years. Although there is evidence of time duration between initiator and event as low as 3 hours and 43 minutes cited in the full scale exercise reports, there is no measurement of the time to the start of exposure consequences in the population. Lower release times were quoted in practice drill scenario information provided by Indian Point, but as with the FSE scenarios there was not a specific measure of impact time on the population. In addition, these were practice drills conducted in the weeks immediately prior to the full scale exercise. They involved practice of a portion of the radiological time line, limited participation of REP personnel (particularly how the off-site organizations) and appear to have been compressed for the sake of staying within a time window for the drill. Based on these observations specific to Indian Point, it appears that there has been very limited coverage of the low end of the planning basis cited in NUREG 0654—specifically release times as low as one half hour, and no full scale exercising of an event with a release time less than approximately three and one half hours.

“Worst Case” Planning and Response

Even without consideration of terrorist actions and the resulting potential for more rapid and/or more sizeable release of radiation, questions can be raised about the accident scenarios used for the Indian Point exercises. The Indian Point probabilistic risk assessment includes hundreds of potential accidents. Yet, it appears that a narrow band of accidents with similar consequences to people around the site has been repeatedly used in the Indian Point exercises.

The accidents used in the Indian Point exercises may be defined as “worst-case,” “internally-initiated” accidents. It is a common maxim in emergency preparedness that “if one plans for the worst, one is protected from all lesser events.” But this is not entirely true. Nuclear accidents cannot be arranged along a single, linear dimension from the “least” to the “worst.” Some accidents can affect large areas but over a longer time. Others can affect smaller areas but consequences occur faster. Each type of accident creates different stresses and problems for emergency managers.

Just as accidents can differ in the stresses they create, so should the response to these events. Emergency planning needs to be flexible and adapt response to the expected event:

[147] *Nuclear Safety in France in 2000*. 2000.

> One way that emergency managers can plan for almost all possible threats, not just one threat at the cost of others, involves a methodology that considers the full range of existing threats *including* the most likely and the worst-case scenarios. E.L. Quarantelli refers to this methodology as the 'all-disaster spectrum approach,' because all risks and their varying degrees of severity are considered.[148] The *all-disaster spectrum approach* identifies the similarities among disasters, giving consideration to the full range of possible disasters in a locality, and devises a general set of guidelines that covers every disaster situation that may arise.[149,150]

It is not necessary or desirable to have a different plan for every contingency. Exercises also cannot test every conceivable contingency. Exercises should, however, test the scenarios that are truly different from each other. In technical terms, these may be called "orthogonal" scenarios—sufficiently different scenarios that stress different parts of the emergency response system.

8.1.4.3 Indian Point and Millstone Exercises and Feedback for Improvement

> *Exercises are not for proving but improving.*[151]

An effective exercise program should identify trends for emergency response capability: Is emergency response capability improving? Degrading? How does preparedness around one nuclear power plant compare to preparedness around other plants?

There should, ideally, be a system to identify and share best practices from one community to another. For example, it takes jurisdictions around Indian Point approximately 12 minutes to sound the sirens to warn individuals after a protective action decision has been made.

We reviewed the Indian Point exercise program from three perspectives to note the feedback for improvement. The first perspective is communications. The second perspective is the frequency of exercises at Indian Point. The final issue is the schedule by which the exercise reports are published.

8.1.4.3.1 Communications at Indian Point

Communications are the lifeblood of an emergency. Communications can also be the Achilles heel. Emergency personnel need to communicate with each other to share information, discuss protective actions and provide feedback on implementation. A slowly evolving event creates a communication load on the participants that can consume precious time, prevent priority coordination efforts from occurring, and negatively impact the ability to assess and direct the response. In a fast-breaking event, communications becomes the key to coordinated and effective action. The result of communication breakdowns can be seen in the response at the World Trade Center on September 11, 2001. The Fire Department of New York could not communicate easily and continuously with the New York Police Department. The Fire Department could not communicate with its own members inside the World Trade Center Towers.[152]

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[148] Quarantelli, E.L. *What is a Disaster? An Agent Specific or an All Disaster Spectrum Approach to Socio-behavioral Aspects of Earthquakes?* (Newark: U of Delaware P, Disaster Research Center, 1981), pages 469-471.
[149] Dynes, Russell R., E. L. Quarantelli, and Gary A. Kreps. *A Perspective on Disaster Planning*. 3rd ed. Newark: University of Delaware Press, Disaster Research Center, 1981, page 110.
[150] Innovative Emergency Management. *Analysis of Contours in Emergency Management*. 1998.
[151] Bruner, Hans H. and Edward Lazo. *Emergency Preparedness—Operational or Paper Tiger? An International Review and Outlook*. 1998.
[152] Mckinsey and Company. "Increasing Fire Department of New York's Preparedness." 2002.

There are indications of problems with communications at Indian Point dating back to at least 1993. The 1999 Indian Point ingestion pathway exercise report mentions problems with communicating with the field monitoring team during the 1993 exercise. Cellular telephones could not establish and retain contact with the Emergency Operations Center for extended periods of time. It was not possible to communicate with the mobile field teams. Finally, in the 1999 exercise, the recently issued cellular telephones were able to demonstrate the ability to communicate with the Emergency Operations Center.

During the 2002 exercise, and during the September 5 drill preceding it, the executive hotline connecting the primary Emergency Operations Centers in charge of managing the event malfunctioned. Putnam County had trouble receiving hotline calls, as the telephone would not ring. Putnam County field monitoring teams had trouble reporting back radiation readings. It was suspected that an individual (or group of individuals) was jamming the frequency. The team shifted to another frequency and was able to communicate. About thirty minutes was lost in this process. In addition, the state Emergency Operations Center had to check the telephones every 30 minutes to ensure that they were still operable. In preparation for the exercise, the state facility had spent all week trying to correct the problems with the telephone system. There were some problems in establishing an e-mail link between the state Emergency Operations Center and the Joint News Center.

The Indian Point emergency response system has been in place at least since the qualifying event for the plant in the early 1980s. The Indian Point facility, the same four counties, and the State of New York have been the parties with the greatest need for communication during emergencies. The problems with communications have not seen rapid resolution, which does not bode well for managing large, sudden emergencies.

Frequency of Exercises at Indian Point and Millstone

Exercises were held every year at nuclear power plant sites until 1996. In June 1996, the Nuclear Regulatory Commission issued a revised rule reducing the requirement of a full-scale exercise from once a year to once every two years. In light of the numerous reviews, changes, increased vulnerabilities, and the performance during exercises, we are recommending that Indian Point jurisdictions perform a full-scale exercise every year. The State of New York advised that they perform full-scale exercises each year that a FEMA exercise is not held. A representative from the State of New York informed us that formal exercise reports are not produced from these exercises. We were not provided dates for these exercises and were not able to view lists of participants for these exercises. Therefore the comprehensiveness of this alternate-year exercise program cannot be assessed.

Many of the requirements of NUREG-0654 and the associated emergency exercise program are levied every six years. Exercises are held every other year. Many Areas Requiring Corrective Action noted at one exercise may be resolved before the next exercise, but a number of corrective actions are deferred to the next biennial exercise. For prompt learning and integration of lessons learned, it may be advisable to have annual full-scale exercises at the Indian Point facility. Figure 8-10 below shows the Area Requiring Corrective Actions and their recommended schedule for corrective action for the exercises at Indian Point from 1996 to 2000.

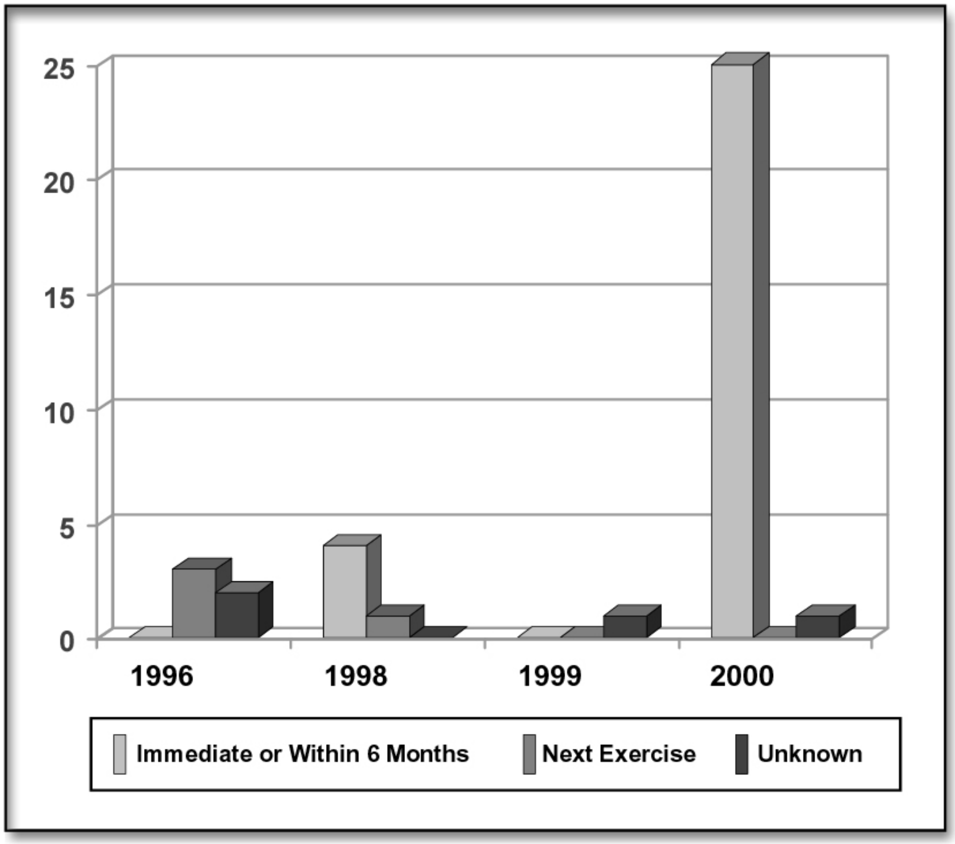

Figure 8-10: History of Area Requiring Corrective Action Correction at Indian Point

There are many nuclear plant security and safety reviews occurring now. These reviews, including the efforts of this report, may result in changes to the emergency response system at Indian Point. A rigorous program of frequent exercises would be necessary to test the emergency response system at the facility, state, and local jurisdictions.

In general, there were few areas evident from the exercise and inspection reports for Millstone that provide direction for exercise improvement. But the above paragraph applies to Millstone jurisdictions as well and may indicate annual full participation exercises are desirable. We also note that approximately 2.5 years lapsed between biennial full-participation exercises at Millstone, which is greater than the prescribed two year lapse.

Schedule of Exercise Reports for Indian Point

For effective learning, feedback needs to be provided as quickly as possible. The Indian Point exercises provide feedback to participants within two days after the completion of the exercise. The release of the final report from FEMA concerning the exercises is often delayed months and sometimes almost a whole year.

Figure 8-11 below shows the number of days for the completion of exercise reports after the completion of an exercise at Indian Point. It is evident from this figure that the final reports have gradually taken more time to finalize.

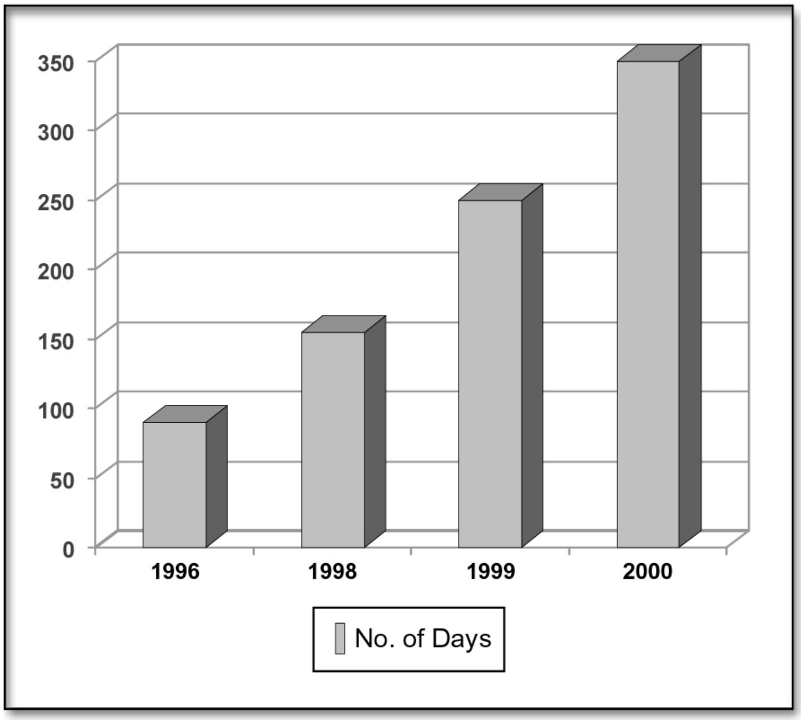

Figure 8-11: Number of Days between Exercise and Exercise Reports

In comparison, all three exercise reports reviewed for Limerick, St. Lucie, and Surry were issued in considerably less time. The Limerick 2002 exercise report was issued in 79 days, the St. Lucie report was issued in 76 days, and the Surry report was issued in 91 days.

The delay in releasing the report by FEMA for Indian Point and its jurisdictions impacts the timeliness of corrective actions and ultimately can erode the effectiveness of the exercise feedback mechanism.

CHAPTER 9
ARCHITECTURE FOR ANALYZING COORDINATED AND INTEGRATED RESPONSE

The preceding eight chapters cover reviews of the Indian Point and Millstone facilities and off-site organizations' hazard assessment, plans, training, and exercises. Despite the detailed assessment of each of these components, it is difficult by that process alone to build a clear picture of the state of preparedness at Indian Point and Millstone. The sum of preparedness is greater than its parts. A component by component analysis does not indicate how the system will respond to emergencies. The need for an integrated view of emergency management is especially evident after disasters. Post-disaster reviews have repeatedly mentioned the need to look across components, at the overall system, to understand what happened and to determine what to do.

In a review of the 1984 **Bhopal** industrial release in India that killed 2,500 people, the Environmental Protection Agency's principal finding was:

> Prevention of accidental releases requires a **comprehensive, integrated approach** that takes into account the hazards of the chemicals involved, the hazards of the process, the capabilities of the facility personnel, and the potential impact on the community.
> [1] (emphasis added)

Congress acknowledged the importance of accident prevention by requiring EPA, under SARA section 305(b), to conduct a review of emergency systems to monitor, detect, and prevent chemical accidents. The final report to Congress stated that:

> …[P]revention does not depend on a single piece of equipment or a single technique. Prevention must be part of a comprehensive, integrated system that considers the hazards of the chemicals involved, the hazards of the process, the hazards to the community, and the capabilities of facility personnel. None of the elements should be considered in isolation nor should any single technical solution be considered a complete solution to a particular problem. **Each change in a facility, process, or procedure will have multiple effects that must be assessed in the context of the entire operation.**[2] (emphasis added)

Integrating emergency management components into a picture is relatively difficult. The doctrine that has been followed in emergency management in the last several decades is to address issues **functionally**. Emergency management plans are divided functionally into emergency support functions. Each function separately addresses the roles and responsibilities of each organization, defines the overall missions to be accomplished under each emergency alert level, and identifies resources available to accomplish the missions. This plan structure mirrors, in general, the structures of emergency response organizations. In an Emergency Operations Center, functional experts in law enforcement work together on their areas of concern, fire personnel work separately on fire issues, and so on. The emergency plans developed by off-site organizations fit the same mold of functional breakdown. An emergency plan lays out each function as a separate

[1] EPA. *Review of Emergency Systems: Report to Congress*. June 1988. Washington, DC.
[2] EPA. *Review of Emergency Systems*. 1988.

part of the plan, often with a clear line of primary responsibility for a single agency to perform the function. Piece by piece, the functional approach allows the whole of emergency response and recovery to be allocated to agencies and organizations.

Accordingly, training is largely conducted along functional lines. Often, each of the emergency agencies conducts its own training to perform the tasks it is responsible for. To fit training into the schedules of agencies that have daily functions other than emergency management, training is limited strictly to the tasks that must be taught. It is very rare to have training that cuts across functional and organizational lines and provides an understanding of the bigger picture of response and recovery. Promoting an understanding of how roles mesh together is left to exercises. However, exercises are evaluated along functional lines also (refer to Chapter 8).

Is this functional approach the optimal arrangement for planning for emergencies? Is it the optimal arrangement for response to disasters? A classic study in organizational theory conducted four decades ago answers these questions.[3] The study compared two factories producing identical products, using the same technologies, and raw materials. In one factory (F), there was a functional division of labor. In another (P), the division was along product lines. The study notes:

> The nature of the organization at Plant F seemed to suit its stable but high rate of efficiency. Its specialists concentrated on their own goals and performed well, on the whole. The jobs were well defined and managers worked within **procedures and rules**. The managers were primarily concerned with short-term matters. They were **not particularly effective in communicating with each other** and in resolving conflict. But this was not very important to achieve steady, good performance, since the coordination necessary to meet this objective could be achieved through **plans and procedures** and through the manufacturing technology itself.
>
> As long as top management did not exert much pressure to improve performance dramatically, the plant's hierarchy was able to resolve the few conflicts arising from daily operations. And as long as the organization avoided extensive problem solving, a great deal of personal contact was not very important…**the functional organization seems to lead to better results in a situation where stable performance of a routine task is desired.** (emphasis added)
>
> …Plant P managers were able to achieve the integration necessary to solve problems that hindered plant capability. Their shared goals and a common boss encouraged them to deal directly with each other and confront their conflicts…**the product organization leads to better results in situations where the task is less predictable and requires innovative problem solving** (emphasis added).

An emergency is far from a predictable, stable environment. It requires innovative problem solving and flexibility in an organization.

The pervasive notion of a functional organization is a relic of the industrial or the Machine Age. In fact, the concept of a functional organization comes from the Machine Theory – the idea that work can be broken into functions, functions into tasks. Under this Theory, each task should be performed the same way each time, bringing efficiency to the work. This idea works quite well in a stable, predictable environment. A functional organization tries to minimize the presence of an external environment. Plans, procedures, rules attempt to define precisely how an

[3] Arthur H. Walker and Jay W. Lorsch, 1968. "Organizational Choice: Product Versus Function" in Jay M. Shafritz and J. Steven Ott. Classics of Organizational Theory. Brooks/Cole Publishing Company, 1992. Pacific Grove, CA.

organization will operate. However, in attempting to use this structure to achieve customer goals, a functional organization creates problems of communication and coordination across its functional units or departments.

Emergencies require flexible response to events as they occur, based on a comprehensive understanding of the goals (products) to be achieved. A product-based organization is best capable of accomplishing the needs of emergency management. It reduces coordination problems and promotes problem solving. It may not be the most **efficient**, but it is the most **effective**.

There is one other point that is relevant. Systems differ in their ability to handle new and greater demands. Some systems are able to learn faster; others take a long time to show any substantive improvements. If Indian Point and Millstone preparedness needs to deal with fast-breaking events, it must increase its “productivity”—that is, it must be able to do more during response in less time. Even here the functional perspective is a hindrance. Going back to the manufacturing case study, there is much greater value in the product approach over the functional approach. Even in a predictable manufacturing environment, where tasks are specific and uncertainty low, Plant P still showed greater resiliency and improvement. Over three years, Plant P showed an increase of 23% in productivity over Plant F’s crawling improvement of 3%. A functional structure could not deliver the level of productivity, largely due to differences in learning and improvement.

In September 2001, FEMA revised its Exercise Evaluation Methodology in an attempt to move toward an “outcome-based” framework for REP exercise observations.[4] The methodology identifies a number of core program capabilities as a focus for exercise analysis and reporting. In addition, the new framework is set up so that findings are analyzed for their root causes. This look at root causes is meant to help reveal to planners where focus is needed in order to improve outcomes. Examples of root causes are doctrinal or organizational deficiencies, lack of training and lack of resources. We analyzed the new FEMA REP evaluation framework as described in the new methodology and observed the implementation of the methodology in practice at the September Indian Point REP exercise(s). We wanted to see whether site-specific outcomes were being defined with input from the New York REP stakeholders, whether the focus was on the right outcomes for public safety, and whether specific measures had been defined and related to specific outcomes. In other words, we were gauging whether objective observations were made that pointed to response outcomes that demonstrated the protection of public safety.

Based on our review of the new exercise methodology and our observations of the Indian Point Full Scale Exercise, we concluded that while the framework espoused in the new methodology is a good start, its principles have not been fully implemented. We did not see site-specific outcomes defined and measured that allowed an objective qualification of the level of preparedness and, more specifically, there was no quantification or associated analysis of the factors that most directly link to the safety of workers and the public. For performance outcomes to mean something, performance measures and associated standards need to be defined, someone has to actually measure them in an exercise and the measurement must be evaluated in relation to the outcome(s). Subjective evaluation against a general set of desired outcomes will not allow a

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[4] Federal Register, Vol. 66, No. 177, Wednesday, September 12, 2001. Notices, Federal Emergency Management Agency. “Radiological Emergency Preparedness: Exercise Evaluation Methodology”

safety judgment that is defensible. In other words, a REP exercise has to be able to clearly demonstrate, using consistent, objective data, that the public safety goal has been served. Saying it has been served without the data to objectively defend the judgment will affect the acceptability of the judgment. This is the main shortcoming we observe in the implementation of the current REP exercise methodology.

To further enhance the "outcome-based" evaluation methodology for REP, a product-based emergency management structure is necessary. In our work in emergency management in the last 18 years, we have repeatedly witnessed the problems caused by the functional approach to emergency management. To solve these problems, IEM developed a product-based emergency management architecture about seven years ago. The Public Protection Performance Architecture (P3A)[5] defines the "products" or performance outcomes to be achieved in managing a response to an emergency. The product-based approach looks at the end points sought by customers. Products are the final items that customers care about – not the internal workings of the plant, not the management structure. In reviews of many disaster case studies and in the course of many consulting assignments across the United States and some overseas, we understand that there are basic services or products that citizens demand[6]:

- Effective, timely and safe **control** of existing or potential hazards
- Timely, accurate, and meaningful public **warning** to persons at risk
- Assistance in **protection** from hazard effects
- Swift fulfillment of the **immediate needs** of displaced or impacted people
- **Restoration** of the community to pre-disaster state or new post-disaster state
- Timely and accurate responses to **requests for information** or response to rumors while all other services are being performed

Of course, all of these customer goals of emergency management are preceded by an understanding of the hazard, or **hazard assessment**.

Figure 9-1 below shows these products or emergency operations goals as a graphic. In the case of nuclear power emergencies at Indian Point and Millstone, the hazard control goal is principally the responsibility of the facilities. Providing accurate and meaningful public warning in time is a shared responsibility of the Indian Point facility or the Millstone facility and the state and local jurisdictions. People must take actions to protect themselves—evacuating, sheltering, taking stable iodine, or washing and changing clothes. However, State and local governments have a very important role to play in assisting in this process. This assistance tries to ***influence*** the public's actions, but can never ***control*** it. This is a very important issue and will be discussed in more detail later in this section.

[5] P3A™ is a trademark of Innovative Emergency Management, Inc. (registration pending).

[6] The customer goals and the management processes appear to be "universal truths" that are raised wherever citizens and elected officials raise concerns about the management of emergencies.

After people are protected, the immediate concern is abated to some degree. However, now citizens may be in reception centers, exposed, injured. Their short-term needs include medical attention, family reunification, decontamination, food, clothing, routine medical supplies, and a host of other services.

Finally, the last goal of emergency management is to restore the community to as close to the state existing before the emergency as possible. This includes payments to victims, long-term cleanup, restoration of services, reentry to homes and businesses. Included in the list of activities are actions to memorialize the disaster, in recognition of the fact that people need closure on traumatic events in order to recover.

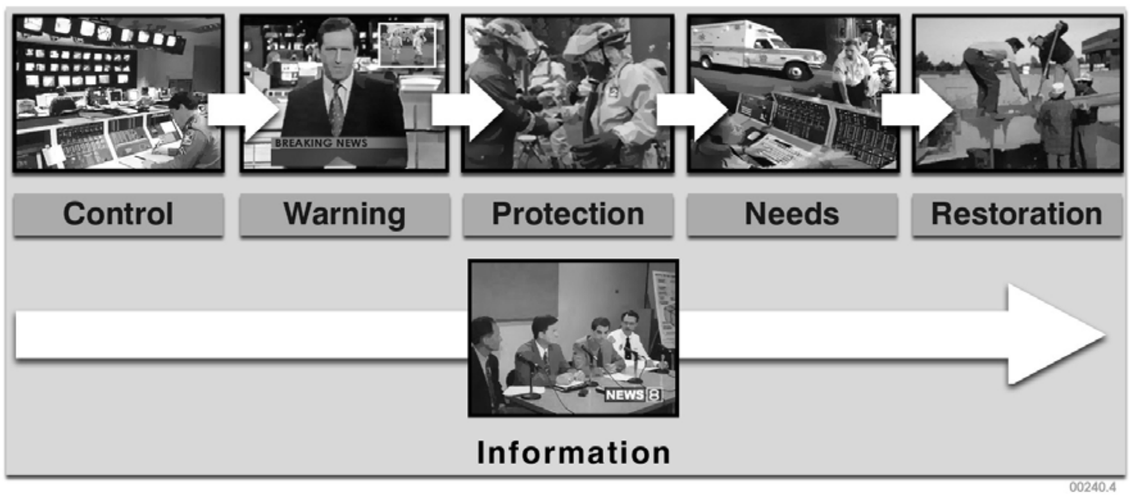

Figure 9-1: Public Protection Performance Architecture (P3A™)

Most functions and tasks performed by emergency managers fit into one of these performance outcomes. A powerful feature of the P3A™ architecture is that every activity is directly or indirectly linked to accomplishing customer goals. Organizing emergency response according to this architecture forces a focus on outcomes about which the customers of emergency management care.

The P3A architecture recognizes that the activities that contribute to any goal are linked together in a chain. A break in one part of the chain makes it harder or impossible to accomplish the outcome at the end of the chain. If one of the activities that leads to public warning is not performed effectively or is not supported adequately by a piece of equipment, the goal of providing accurate, timely, and meaningful warning to the public is jeopardized.

On a more macro level, the customer goals are arranged in some semblance of the order of importance. Restoration is arguably of lesser importance than providing warnings and assisting people in taking protection. This understanding may guide planning, training and exercises. The focus can be, and often is, on preparing for warning and protection first until these goals can be adequately served.

In the Indian Point exercise program, emergency management is judged along 33 functional objectives. In the product approach outlined above, there are six goals. Surely, it is better to measure more than to measure less? The experience of the Government Performance and Results Act of 1993 indicates otherwise.[7]

The P3A architecture is a framework for implementing the philosophical approach of the GPRA in the crucial area of emergency management and Homeland Defense. The P3A customer goals are outcome measures – they define emergency management activities in terms of what customers receive. The Government Performance and Results Act of 1993 guidelines recommend the following:

Establish a Results-Oriented Set of Measures That Balances Business, Customer, and Employee.

- **Define what measures mean the most to customer, stakeholder, and employee** by (1) having them work together, (2) creating an easily recognized body of measures, and (3) clearly identifying measures to address their concerns.
- **Commit to initial change** by (1) using expertise wherever you find it; (2) involving everyone in the process; (3) making the system non-punitive; (4) bringing in the unions; and (5) providing clear, concise guidance as to the establishment, monitoring, and reporting of measures.
- **Maintain flexibility** by (1) recognizing that performance management is a living process, (2) limiting the number of performance measures, and (3) maintaining a balance between financial and non-financial measures.

Collect, Use, and Analyze Data

- **Collect feedback data**, which can be obtained from customers by providing easy access to your organization.
- **Collect performance data** by (1) investing both the time and the money to make it right, (2) making sure that your performance data means something to those who use them, (3) recognizing that everything is not on-line or in one place, and (4) centralizing the data collection function at the highest possible level within the appropriate organization.
- **Analyze data:** (1) combine feedback and performance data for a more complete picture, (2) conduct root-cause analyses, and (3) make sure everyone sees the results of analyses.

Policies, plans and procedures, training, leadership, equipment, and facilities contribute to the performance of these customer goals. During operations, there are tasks emergency managers and response personnel perform that do not directly contribute to the customer goals. These tasks may be associated with keeping communication lines open, managing the inflow of response personnel, tracking resources and equipment in use. There are tasks that emergency managers need to perform to keep the emergency management structure operating smoothly. The P3A architecture recognizes these as **management processes**. Management processes are bundles of

[7] The Government Performance Results Act requires that federal agencies develop performance measures to track services that are provided to citizens. Many federal, state, and local agencies have developed performance measures.

activities that are preformed by emergency managers and response personnel to keep the emergency management system performing smoothly. The P3A management processes are:

- Communications
- Coordination
- Decision-Making
- Resource Management
- Personnel Management
- Control and Integration

Communications activities allow emergency personnel to communicate with each other. The P3A architecture distinguishes these activities from the systems used to provide information to the public. Communications, in P3A parlance, is restricted to the communication systems used to link emergency personnel.

Coordination is not possible without communications. Again, P3A defines coordination as the set of activities for emergency personnel to link their actions together. In any nuclear emergency, hundreds of emergency personnel are expected to be involved in response and recovery. Coordination activities link these personnel so that individual actions are channeled toward the emergency goals.

Decision-making is based on communication and coordination. Decision-making requires information on what is happening and what may happen. Information on what is happening is generally communicated from multiple emergency personnel in the field. An integrated picture of current events is critical to decisions on how to intervene further. Decisions also must be coordinated among counties, between counties and the State, and between the civil jurisdictions and the nuclear facility. In any nuclear emergency affecting Indian Point or Millstone, many different federal agencies are expected to be involved. Therefore, decision-making is reliant on the processes of communication and coordination.

Resource management must contend with the challenge that, at the time of an emergency, local resources are all that are available. Within hours or days, a much larger set of resources can be mobilized from around the region, and across the country. But, initially (perhaps for as long as 72 hours) local resources must be managed to provide the greatest support for emergency goals.

Personnel management is also necessary for emergency management enterprise. Response personnel may need to monitor radiation in areas and must be suitably trained and attired to perform their tasks. There has been, for the last decade, a documented issue of personnel convergence. In most emergencies, volunteers and emergency personnel from surrounding jurisdictions converge on the disaster site and offer their services. Managing this large army of "reserve" personnel can become a large chore of its own.

Control and integration provide the means of conducting situation assessments and making overall decisions on how to proceed with response in the face of changing conditions. The hazard conditions may change, community conditions may change, or management options and resources may change. Control and integration activities accomplish this role.

Each of the management processes is involved in each of the customer goals or products. For example, to assist in protection, emergency personnel need to communicate to each other in manning traffic control points. They need to coordinate with other counties to ensure that traffic moving from one county will not be blocked in another county. They may receive information on the level of traffic indicating a higher or lower level of evacuation response than desired and make decisions to provide further information to the public. Traffic management resources may be managed, including police cars, traffic cones. The location of traffic control point personnel may be tracked to ensure that they do not inadvertently remain in areas projected to be in the path of the plume. Finally, conditions can change during disasters – the wind shifts and new areas are at risk, hazard can escalate or be controlled, people may under-mobilize or over-mobilize, etc. All these situations require an ongoing assessment of the situation and a cohesive response to the changing conditions. That is the role of the control and integration activities.

Emergency management is an "open"[8] system. A system is composed of interrelated parts that work together in complex ways so that it is not possible to understand the whole simply by examining the parts. In short, the sum is greater than the parts. The emergency management system is open because it interacts with components that lie beyond its boundaries—that is, it attempts to impact and receives feedback from the people that it must protect. In contrast, a nuclear power plant is largely a closed system, i.e., it does not usually interact with its boundaries. A closed system can be understood largely by considering the parts that compose it, without a great deal of consideration for what lies beyond the boundaries of this system.

Most of the emergency management goals listed above require actions and behavior by the public at risk. Emergency management actions would fail miserably if people did not heed warnings, take protective actions, or assist in family reunification. Emergency managers take inputs from the environment and convert them into actions. These actions affect the public and the public's reaction feeds back into the emergency management system so that further actions can be taken. During a response, such feedback becomes paramount: Are people mobilizing fast enough? Are people evacuating in areas other than those recommended for evacuation? Are people displaying health effects of exposure?

Computer-based modeling is a useful tool for understanding both open and closed systems. For instance, modeling is used in the design and operation of nuclear power plants. Modeling is also used to predict what accidents could occur based on specific plant parameters. Nuclear processes are understood very well from the engineering side of the house, and grounded in the rigorous discipline of nuclear engineering.

But the same is not applied to the emergency management side of the house. No engineering is applied to the issues. There is no map of the emergency management system and how it is 'wired." Indeed, current emergency planning, training, exercises, and public education is largely not based on a scientific understanding of human behavior.

[8] The word "open" here does not connote the common meaning of the term "trust" or "openness of communication". It defines the degree of interaction with the boundaries of the system.

> Existing plans take little cognizance of the extensive research on human behavior during accidents and disasters, and a public perception of nuclear power risks….Behavioral research can indicate how the public may respond, and this may influence the choice of protective actions, the size and shape of the planning areas, and the locations of evacuation routes and mass care centers. Such work can also indicate how these plans should be implemented, including the structure of education and notification systems, and the most effective method of relaying information and achieving compliance.[9]

Recognizing the differences between a person and a machine, nevertheless, like a nuclear plant, emergency management requires similar sophisticated modeling. And, since most emergency actions are directed toward people, there is a dire need for modeling social processes as a part of emergency planning, training, and exercises. This modeling is, by necessity, more complex. Human processes have to be modeled with other components, such as hazard dispersion, traffic engineering (to predict evacuation time and congestion), mechanical engineering (for shelter effectiveness), and emergency process modeling (for emergency management actions).

The P3A architecture recognizes that application of a rigorous, customer-based approach to emergency management will require integrated, end-to-end modeling tools that can cascade the effects of problems in one part of the system to the end results sought by the customers. And, embedded as an integral part of these tools must be as clear and detailed an understanding of human behavior under extreme events as is possible.

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[9] CENTED (Center for Technology, Environment, and Development, Clark University) Queens College, and SIAC (Social Impact Assessment Center), 1987. Issues in Emergency for the TMI Region: An Interim Report for the Three Mile Island Public Health Fund. Worcester, MA: CENTED.

CHAPTER 10 EXERCISE ANALYSIS USING THE PUBLIC PROTECTION PERFORMANCE ARCHITECTURE (P3A)

The most important measure of any exercise is the level of protection afforded to the populace against the accident scenario. Considering the importance of exercises in testing capabilities and improving plans, the observation of the Indian Point drill and full-scale exercise was another component of our review. The JLWA/IEM team collected data from both the practice exercise and the full-scale exercise at Indian Point in 2002. As no exercises were conducted at Millstone during the time of this report, no exercise observations for that site are presented here. The purpose of the practice exercise was to work out "the kinks" in the exercise scenario. The full-scale exercise was an actual test of the ability to protect the public from an accidental release of radiological material from Indian Point.

Also, given the importance placed on exercises in the radiological emergency preparedness plan approval process, we observed the exercises in order to consider whether this reliance on exercises, as they are currently structured, in making that determination is appropriate.

On **September 5, 2002**, a practice exercise was conducted in the plume exposure pathway Emergency Planning Zone around Indian Point 2 by the State of New York. Eight JLWA and IEM observers were present at the exercise. They were stationed at the New York State Emergency Operations Center, Putnam County Emergency Operations Center, Westchester County Emergency Operations Center, Rockland County Emergency Operations Center, Orange County Emergency Operations Center, the Joint News Center, and the Indian Point EOF. At least one observer remained at each location during the entire exercise. Observers collected exercise data for evaluation and analysis.

The practice exercise scenario consisted of a radiological release due to a failure of a containment isolation valve. The valve failure was caused by a series of other system failures. The exercise began at approximately 8:20 am with a leak in the pressurizer surge line. Due to the leakage of water from the reactor coolant system exceeding the capacity of a single charging pump, an Alert was declared by the Indian Point Energy Center at 8:37 am. At 10:26 am, a Site Area Emergency was declared due to the large amount of water leaking from the reactor vessel and the potential for fuel to become uncovered. A General Emergency was declared at 12:45 pm. The General Emergency was declared because two of three fission product barriers had been lost and there was potential for the third to be lost and containment breached. People in 16 Emergency Response and Planning Areas were simulated to be issued initial Protective Action Recommendations at the declaration of a General Emergency.[162]

[162]This action was based on a prevailing wind direction of 220° at 10 miles per hour and Pasquill Stability Category B.

The simulated release occurred at approximately 1:38 pm. After the radiological release, three additional Emergency Response and Planning Areas were issued Protective Action Recommendations, based on a prevailing wind direction of 150° at 13 miles per hour and Pasquill Stability Category D. At 2:29 pm, the simulated radiological release ended. At 2:41 pm, the simulated emergency was terminated and the exercise was declared to be at an end.

It is important to note that the operations group at Putnam County participated only until 12:00 pm. The practice exercise, in its entirety, was played out-of-sequence in a compressed time scale for this group.

On **September 24, 2002,** a full-scale exercise was conducted in the plume exposure pathway Emergency Planning Zone around Indian Point 2 by the FEMA, Region II. Ten James Lee Witt Associates and IEM observers were present at the exercise. They were stationed at Emergency Operations Centers in the State of New York, Putnam County, Westchester County, Rockland County, and Orange County, as well as the Joint News Center and the Indian Point Emergency Operations Facility. At least one observer remained at each location during the entire exercise. Two observers moved between the Indian Point Control Room, the Indian Point Emergency Operations Facility, Westchester County Emergency Operations Center, and the Joint News Center.

We evaluated the September 24, 2002 exercise at Indian Point using the P3A architecture. Because of the scope of the exercise, we restricted the analysis to reviewing two of the customer goals in the P3A architecture:

- Timely, accurate, and meaningful public **warning** to persons at risk
- Assistance in **protection** from hazard effects

Figure 10.1 below shows some of the activities under the two P3A goals.

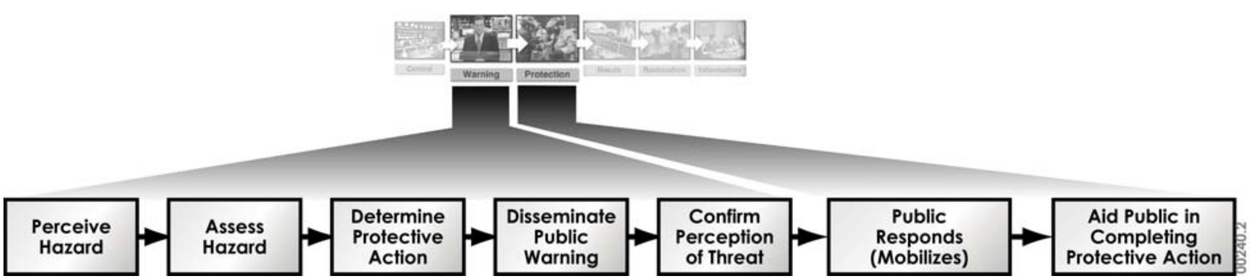

Figure 10-1: Emergency Management Critical Path Response

The discussion below does not cover each of the activity boxes defined in Figure 10-1 above. Instead, we used a simple method to analyze the capability of the emergency response system to afford protection as shown in the September 24 full-scale exercise. Figure 10-2 below shows the results of this simple analysis.

The scenario for the Indian Point full-scale exercise consisted of a radiological release through a plant vent due to a loss of pressurization. The loss of pressurization was caused by a series of system failures. The exercise began at approximately 8:20 am. Due to multiple losses of electrical power, an Alert was declared by Indian Point at 8:43 am. At 11:26 am, a Site Area Emergency was declared due to very large radiation readings inside primary containment.

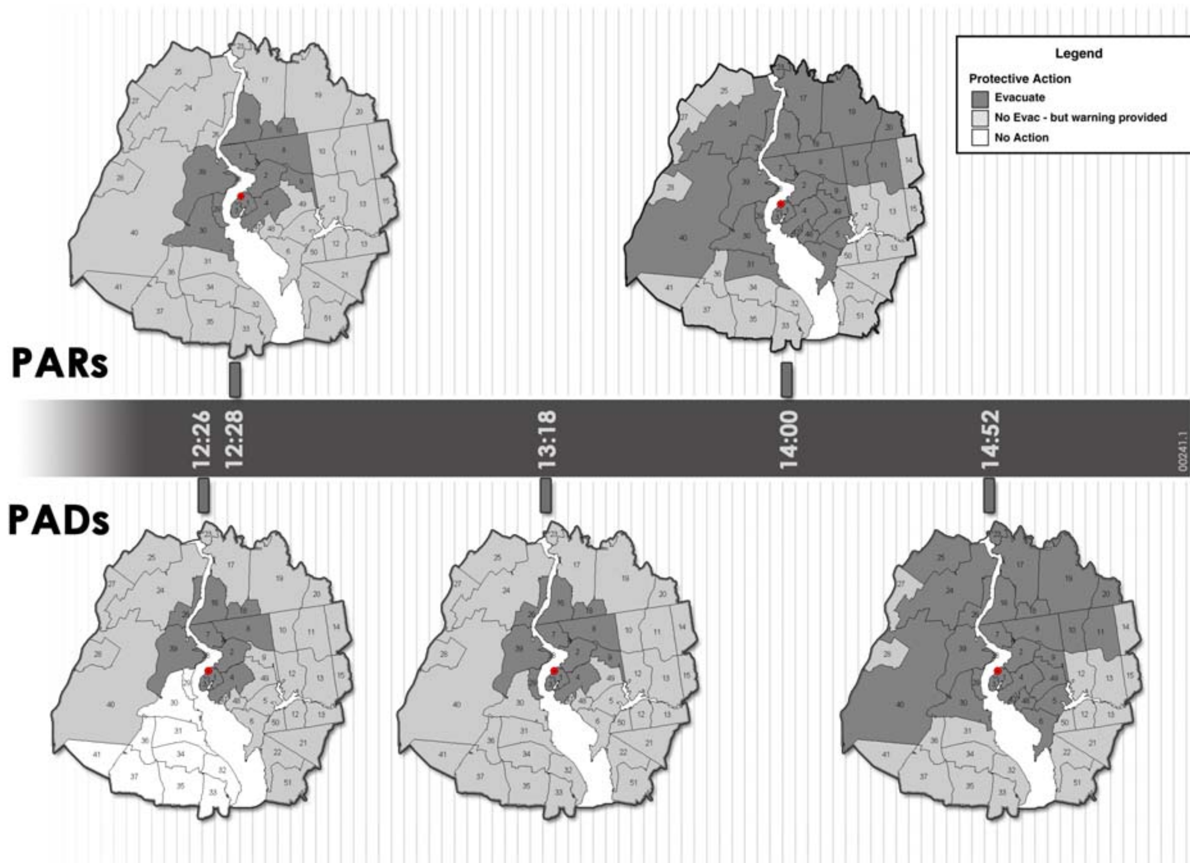

Figure 10-2: Protective Action Recommendations Versus Decisions at Various Stages of Response

Figure 10-2 shows the zones that were recommended for evacuation by the Indian Point facility as protective action recommendations. It shows the zones that were told to evacuate by the counties as protective action decisions.[163] A General Emergency was declared at 12:22 pm. The General Emergency was declared because of increasing radiation readings inside primary containment, with potential for a containment breach. At 12:28 pm the Indian Point facility recommended that specific zones be warned. The counties decided to warn them a few minutes earlier, but did not warn all the zones that the facility was subsequently deemed to be potentially at risk. People in 15 Emergency Response and Planning Areas were simulated to be issued initial Protective Action Recommendations at the declaration of a General Emergency[164]. At 1:18 pm, the counties added more zones to the areas warned but not all of the zones initially recommended by the facility.

[163] The difference between protective action recommendations and protective action decisions lies in the role of government versus a private corporation. Government is responsible for making the decision to inform people that they are at risk and that they need to take protective actions.
[164] This action was based on a prevailing wind direction of 205° at 12 miles per hour and Pasquill Stability Category C.

The simulated release occurred at approximately 1:46 pm. Within about 15 minutes, the Indian Point facility notified off-site authorities at Orange, Putnam, Rockland, and Westchester counties and the State of New York. Protective action recommendations were provided at the time of notification as shown in the 14:00 PAR entry in Figure 10-2. A little while later, the Counties warned people in 17 additional Emergency Response and Planning Areas to take protective actions.

The rest of this analysis focuses on a single area: Emergency Response and Planning Area 19. This Emergency Response and Planning Area lies in the northeast quadrant of the Indian Point area in Putnam County. There were approximately 6,805 people in this zone in 2000. Putnam County received notification of the release at 2:00 pm from the Indian Point facility. About half an hour later (2:37 pm in IEM observation logs), the county decided to upgrade the sheltering recommendation to evacuation, based on the notification of the release. At 2:49 pm, sirens were activated to alert people. At 2:52 pm, the Emergency Alert System broadcasted a message telling people in the region that the sheltering recommendation had been changed to an evacuation. People in the selected zones, including the Emergency Response and Planning Area 19, were told to evacuate.

Figure 10-3 below shows the progression of these events. The bottom row of boxes shows the actions of the emergency response system at the Indian Point facility and emergency management personnel at Putnam County. The second row shows the effect of these actions on one of the key social processes: diffusion of public warnings. Since the public was notified at 10:11 am via sirens and 10:14 am via the Emergency Alert System that there was a potential problem at Indian Point, the warning that something was wrong was diffusing already through the population. With each siren and Emergency Alert System message, an increasing number of the population at the Indian Point region became aware of the problem at Indian Point. Finally, at 2:52 pm the Emergency Alert System sent out the message that people should evacuate.

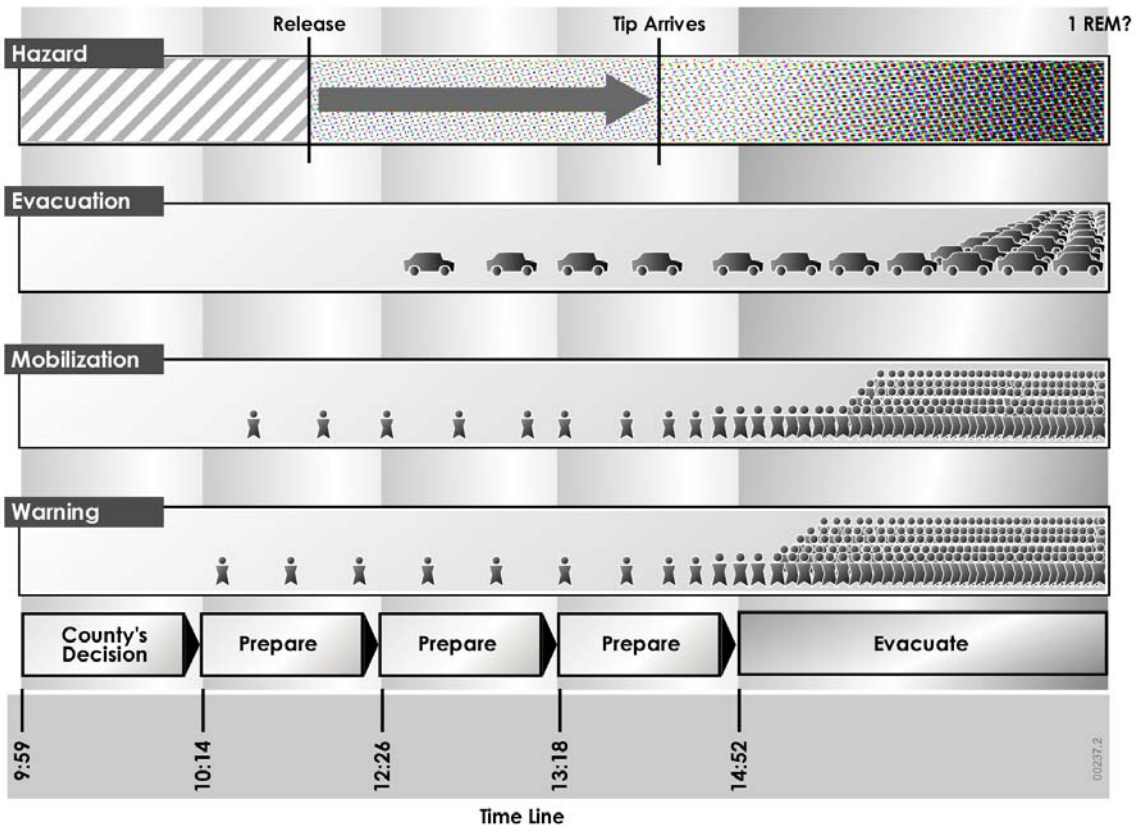

Figure 10-3: Progression of Events in Emergency Response

The third row shows another important social process: mobilization. As mentioned in Section 5.2, people make their own calculations and decisions of what they will do when warned by emergency officials. This decision making and subsequent mobilization to take action is **influenced** by what they hear from emergency officials, who they hear it from, how often, and how it is interpreted by them. However, emergency officials cannot **control** this social process. With each successive alert and notification and the diffusion of the warning, more and more people continue to mobilize to take some action.

Some of these people can be expected to start evacuating, regardless of what emergency managers are currently recommending as the appropriate protective action. The Marist poll conducted for Riverkeeper found that 76% of the respondents within the ten-mile EPZ said they would evacuate when asked if "In the event of a major accident at the Indian Point Nuclear Power Plant, would you attempt to evacuate your area, or not?" Because this question was not qualified by mention of whether emergency managers were recommending an alternative protective action based on wind direction or other considerations, we believe this estimate to err on the high side. Case studies of previous emergencies and public intention surveys show that spontaneous evacuation for a radiological emergency from the area encompassed in the 50 mile radius may be around 10-15%.[165] However, because of the controversy surrounding Indian Point and the expressed public concerns with safety, the rate of spontaneous evacuation in the Indian

[165] This should not be confused with "shadow evacuation." Shadow evacuation is the tendency of people outside the areas recommended for evacuation to leave the region. This issue is related to people in the potential risk areas leaving before they are told to evacuate.

Point area may be higher. The rate of evacuation can be expected to vary by distance from the site—much higher percentages of people evacuating from near the site with a gradual reduction in the evacuation rate away from the site. Any answer between the Marist poll results and these case studies is still a significant number of people and vehicles; a concern the reader will find woven through this report.

Post-disaster research indicates that a majority of the people will leave after officials indicate that they should evacuate. The percentage of people leaving is highly variable—from less than 50 percent to almost 100 percent of the people in the region. The compliance rate may vary based on characteristics of the population (by ethnic groups, distance from the hazard, socioeconomic and educational status, etc.) and characteristics of the emergency response organization (the warning spokesperson, how the warning message is crafted, etc.). There is a lag between the time that alert and notification systems provide their warnings, and when these people actually start to show up on the roads in the area. This lag, of course, is the time for the warning to diffuse and the mobilization to occur. Slowly, people receive the warning and are convinced to take action. This results in a "loading curve" where first a trickle, then an increasing flood of vehicles start to travel along the area roads. Based on the findings from previous events, all the vehicles are not expected to enter the roadway system all at once. The second row in Figure 10-3 shows this build-up of evacuating vehicles.

The simulated release occurred at approximately 1:46 pm during the exercise. The radiation plume, borne by the winds and mixing with the ambient air, made its way across the landscape slowly. The final row of Figure 10-4 shows the movement of this plume. We did not perform a sophisticated assessment of the movement of this plume. Taking a simple straight-line projection of the movement of the plume, the leading edge (the tip) of the plume arrived at Emergency Response and Planning Area 19, about five miles away, at about 2:15 pm. This zone was not told to evacuate until about 40 minutes later. Even if the majority of the people were warned and mobilized already, they still needed time to leave. The evacuation time estimate would calculate and provide the time needed to evacuate this zone.

On the surface, the actions of emergency management were too late. However, an important factor must still be considered. The purpose of radiological emergency preparedness is to prevent doses at or above 1 rem. The tip of the plume is a much lower threshold of exposure. Therefore, additional time can elapse before the health of a population is at risk. The precise time would require a more sophisticated analysis. People in Emergency Response and Planning Area 19 may have had just enough time to evacuate from the area before they were exposed to 1 rem. We cannot determine that with this simple analysis, nor is it necessary to validate our point.

It is possible to "outrun" the plume. The plume was moving at about 12 miles per hour. If individuals could move out of the path of the plume faster than the "arrival" rate of the plume, they would still be able to avoid the health effects of radiation. The ability to outrun the plume lies with the rate of mobilization, the configuration of the roads (whether they are aligned to move in a radial direction away from the hazard), and the extent of congestion on the roadways (speed of travel).

The extent of dose reduction or dose savings for the people in an Emergency Response and Planning Area is not known unless there is a simulation that combines the social processes of warning and diffusion, the actions of emergency management, traffic modeling showing the effects of people's response on the traffic network, and an integrated modeling of radiation dispersion effects on the people inside homes and offices versus people leaving in their vehicles.

How would this response differ in case of a fast breaking event? If an event occurs and immediately there is a General Emergency, it would be very important to alert and notify quickly. Sirens and Emergency Alert Systems would be used. But, as Figure 10-4 below shows, experience with chemical emergencies has shown there is an approximately 50% improvement in warning diffusion with Tone Alert Radios.

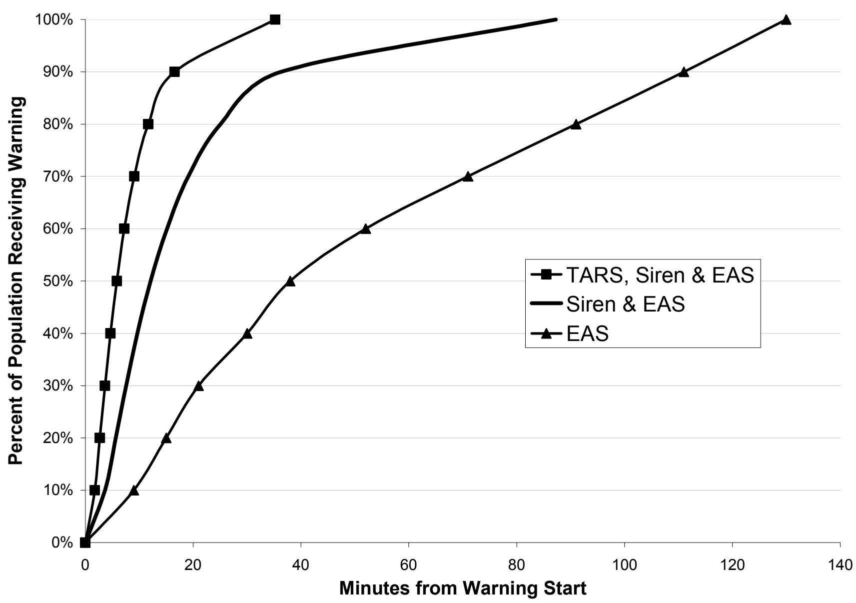

Figure 10-4: Warning Diffusion for a Combination of Selected Notification Systems[166]

There is another issue that must be considered. Is evacuation, under these circumstances, the best option to protect the people in Emergency Response and Planning Area 19? Perhaps sheltering in place might be better. There is a potential that the people in this zone may be leaving in their vehicles at the precise time that exposure to the outside is most dangerous to their health.

The selection of the right protective action is very important. An example from Chernobyl can illustrate this important point:[167]

> Different countries followed different approaches in implementing protective measures, including considerable improvisation as the accident progressed. The result was great variation in choices of

[166] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615), Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

[167] For a variety of reasons, the most important of which is the type and magnitude of the accident, it is not appropriate to compare the accident at Chernobyl in 1986 to potential nuclear accidents in the United States. However, the experience does illustrate the value of determining the appropriate protective actions. The Chernobyl accident was of international scope affecting a large number of countries.

> measures, levels of protection sought, and the vigor with which measures were put into effect. Only some of the differences can be attributed to differences in levels of exposure.[168]

These differences in protective action strategies led to some important differences in health effects. Some countries did not reduce any of the radiation dose to their citizens. Other countries were able to cut the dose received by their citizens in half, for even a catastrophic accident such as the Chernobyl release. Such lessons learned should be borne in mind when evaluating the framework for protective action decision-making in the area around Indian Point.

[168] Robert L. Goble and Christoph Hohenemser. "Emergency Planning Lessons from the Accident at Chernobyl" in Golding Kasperson and Kasperson, 1995. Preparing for Nuclear Power Plant Accidents, Westview Press.

CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS REGARDING PUBLIC SAFETY

11.1 Conclusions

In the sections that follow it is important to recognize that assumptions and hypothetical scenarios are not predictions. The reader is cautioned too that the conclusions and recommendations regarding the two plants under consideration here may not be applicable to other plants, regardless of ostensible similarities.

The recommendations in this report result from a large number of detailed observations across many facets of the emergency preparedness systems at the Indian Point and Millstone sites as well as observations made at the state and local government entities responsible for public safety in the plume emergency planning zone. Supporting the recommendations is a large volume of information obtained through interviews with plant operations personnel, emergency managers and emergency services workers in counties and municipalities, key department or agency personnel at the State of New York, and a number of experts in emergency planning for radiological accidents.

We have identified areas that would significantly improve with only a small amount of corrective action and, other areas that need major changes that will take the commitment of significant resources and time to address. Dated evacuation time estimates for both Indian Point and Millstone may not accurately represent the number of vehicles and people that may use the evacuation network if an accident were to happen today. Fortunately, in the case of Indian Point, both the population and evacuation time estimates are currently undergoing a major update. Nevertheless, the greatest problems do not lie in these specific areas.

The greatest problems cut across the individual emergency preparedness functions. The problems lie in the **interoperability** and connectivity of the individual functions, often performed by different agencies, under different regulations. It is an additional problem that these interoperable/connectivity issues are not clearly evident when looking at radiological emergency preparedness as isolated functions and activities that comply with individual regulations. However, the broader problems *are* evident when looking at emergency management as a system-of-systems and from the point of view of a customer.

Who is the customer of emergency management, and what does he or she want? If there is an emergency and a person's life or health feels threatened, that person is customer of emergency management. He or she will almost certainly want the following things from the emergency management system:

- Accurate, timely, and meaningful **warning** about the threat to safety or health

- Effective, timely and safe **control** of the source of the threat and/or apprehension and justice for those involved
- Assistance in knowing how to **protect** oneself and assistance in taking action to do so
- After the initial impact of the event, **short-term stabilization** services to help one reunite with loved ones and attend to medical and other needs
- Support in a **recovery** back to normal existence in the **long term**, perhaps shaped subtly or indelibly by the event that occurred, and
- While all these activities are in progress, an honest, understandable, and meaningful **response to information needs** that communicates what has happened, what could happen, and how it might affect one's life

All emergency activities fall in under one of these customer needs. When viewed from this perspective, it becomes evident that there are some significant disconnects in how the Indian Point emergency response system is organized and how it functions. A number of these observations also apply to the emergency response system for Millstone. Our analyses indicate that the State of New York, the affected counties, and the licensees should focus preparedness improvement efforts in five key areas: dose assessment, warning, protection strategy, response to information needs, and communications. Addressing these areas will require that the State and local jurisdictions, and FEMA, address significant planning, training and resource issues. It will also require a major departure from the focus on compliance with regulations that now limits effective radiological emergency preparedness efforts at the local level.

11.1.1 Issues with Meeting Emergency Needs

11.1.1.1 Accident Analysis Outputs are not Integrated into Plans, Training, Exercises and Public Information—HAZARD ASSESSMENT

"*…[G]ood preparedness is actually a knowledge-based, realistic process stressing general principles aimed at reducing the unknowns in a problematical situation.*"[169]

Management of an event requires first grappling with what has happened. This is particularly true for large-scale events, and even more significant for fast-breaking events. The technical term for this activity is **hazard assessment**.

Nuclear hazards are invisible and silent; however, they are detectable with proper equipment. To deal with the invisible, it must first be made visible. This requires the use of some type of technology, be it paper or computer-based, to predict what may happen and how it may affect people. The Indian Point or Millstone facilities are the lead players in this process.

For this aspect, the Indian Point facility relies on older vintage technology, 1970's era operational techniques (map, standardized overlays), and multiple computer codes (MIDAS, MEANS, MRPDAS) that are not well integrated. Plant personnel specifically do not have a sophisticated means to calculate how much time is available for various communities to take

[169] Quarantelli, E.L. *Community and Organizational Preparations for and Responses to Acute Chemical Emergencies and Disasters in the United States: Research Findings and Their Wider Applicability*. Disaster Research Center, University of Delaware. 1988.

protective actions. There is no swift and coordinated method to transfer this information to the communities, and there are a limited number of communities that get the information directly. The Indian Point facility and the surrounding communities rely on facsimile machines and telephones to relay information. This limits what can be sent: detailed, rich, map-based information that conveys who is at risk and by when is not currently sent between the facility and the communities. Also, the ability to react to changes in the prediction, based on real-time measurements is hindered, without an automated system in place.

While Millstone uses a more modern and capable dose assessment computer code, it is generally used later in an event. This negates the potential benefit of early protective action recommendations and decisions based on the best dose assessment. As with Indian Point, the computer systems are not capable of automated transfer of the hazard information. Transmittals are via fax or phone so there is no benefit of an integrated system to provide accurate, consistent hazard information free of other communication system and human filters. In other words, the current approach increases the potential for translation and interpretation difficulties.

Computers can predict, but real data on the radioactive products of a release is needed to determine where the actual effects are in the community. There is a large emphasis on field monitoring in the off-site response program. First responders are expected to go to points in the community and measure radiation. These activities are being performed in the early phases of an event—while citizens are still taking protective actions.

We could not discern the basis at either facility for this early emphasis on monitoring. The regulatory documents underlying nuclear preparedness clearly state that initial protective actions should be taken on the basis of computer projections. First responders should not be sent out into potentially contaminated areas simply to establish the boundaries of the areas affected by the event. Additionally, arrays of detectors and monitors that continually provide real-time detailed information about the radiation status obviate the need for putting such first responders at risk.

If field monitoring is important enough to require efforts from first responders, there should be a commensurate urgency to integrate this information into emergency actions. We could not find a clear process for the gathering and use of field monitoring data from the county and state field monitoring personnel to the Indian Point or Millstone facilities for incorporation into the computer codes or map/overlay methods that predict dispersion of the radiological plume.

The migration by the State, the counties and of Indian Point facility to a minimum of the RASCAL version 3.0 is a positive improvement. The code will provide a better common basis for conducting and sharing dose assessment and will better accommodate the terrain around Indian Point and specific cases where the wind shifts significantly. However, RASCAL alone will not address the need for better automated sharing of information and the expansion of this sharing beyond county emergency operations centers and the Joint News Center to other entities in the emergency planning zone. In addition, the migration to the new code will require training and additional coordination measures that must be adequately addressed for the full benefit of the RASCAL migration to be realized.

The fact that Millstone uses a different set of tools for dose assessment poses a challenge for the State of New York. Because a different code is being used, the assessment for the impact of a Millstone accident on the population in New York (Fishers Island and Plum Island) may look different and be communicated differently than an assessment done in RASCAL. The State must carefully consider what hazard information is communicated to Fishers Island and Suffolk County and in what way. The potential exists for the Millstone licensee or the State of Connecticut to communicate different hazard information than the State of New York, although the current New York plan states that the Millstone/Connecticut dose assessment will be used. It is not known at this time how the move to RASCAL 3.0 will impact this policy, if at all.

For either Millstone or Indian Point, once the utility determines that there is a problem and provides notification to the community, the information passes to the county level and to the States of Connecticut or New York respectively. Cities (municipalities) are not directly informed (the notable exception being Fishers Island). Instead, they must wait for notification from the counties. This practice results in delays and has the potential for no information, incomplete information or conflicting information to go to the cities. This problem will be exacerbated once the "alternative sources" such as the news media, existing networks among emergency services personnel, etc. start reporting on conditions at the plant. The lack of direct and accurate flow of hazard information may also exacerbate other problems such as shadow evacuation, spontaneous evacuation in the plume exposure emergency planning zone, and role conflicts for emergency services personnel.

11.1.1.2 More and Better Means of Reaching and Warning People are Needed – Both Pre-Event and Post-Event —WARNING

One of the most important emergency response functions that public agencies can perform is to provide adequate, timely, and meaningful warning of impending threats of events that have already occurred. At the Indian Point site, the warning component includes sirens to alert the community that an event may have occurred or has occurred. The sirens are required to be loud enough to be heard over background noise. In some hilly parts of the community surrounding Indian Point, existing sirens cannot be heard. Tone alert radios have been provided to the people who live in these areas. All areas are covered by the Emergency Alert Systems. These are the interruptions to regular programming that provide emergency messages in a variety of media, such as radio and television.

There are a number of problems with this arrangement. Sirens are essentially outdoor warning devices; most of the time, people would hear the sirens if they were outdoors, but may not hear them indoors. Tone alert radios are indoor warning devices and generally require the person to be indoors to hear the tone alert device. The Emergency Alert System is effective for alerting people who are engaged in mass media, such as listening to the radio or watching television. People can be better alerted by a combination of the various media pathways through which the alerts are sent. Emergency researchers who have investigated this point have shown, using scientific evidence, that a combination of alerting devices reaches more people, faster.

Sirens can also be equipped with voice capabilities to transmit warning messages. Voices can be prerecorded or live (they are probably best if they are from the chief elected official). They may simply request hearers to tune to the EAS message, they may discourage spontaneous evacuation in areas not threatened by the hazard, or they may contain some other simple message. Multiple languages can be used. Communities across the nation have had some positive and some negative experiences with voice-capable sirens, and these experiences should be considered if an effort is undertaken to improve the alert and notification system. We have not found indications that adding voice capability to sirens around Indian Point has been considered.

While the terrain effects around Millstone are far less pronounced, the alert and notification planning basis is somewhat dated and could be improved with currently available technology. It was not clear to reviewers whether the sound levels required by applicable regulations were in fact achieved in the study for Fishers Island. The State of New York may want to explore this particular issue further.

At any given snapshot in time, a large number of people can be expected to be on the roadways around Millstone and Indian Point. These people must be warned. Many may hear the sirens and receive an Emergency Alert System message; however, there is now supplemental technology available to boost the warning: highway readerboards. These readerboards have been used effectively in other US communities to warn motorists of hazardous events. The technology also has dual-use potential. For example, readerboards are being used in some communities to warn citizens of child abductions.

Readerboards are important in other ways besides increasing the overall effectiveness of the public warning. There will be a potential for “shadow” evacuation during a nuclear event. Shadow evacuation is the spontaneous evacuation of people who are located outside the recommended evacuation zones. Readerboards can help control shadow evacuation inside and outside the Indian Point plume exposure emergency planning zone. Although there is no need for readerboards on Fishers Island or Plum Island, Suffolk County should consider their use to reduce the degree of shadow evacuation on Long Island.

A further warning consideration for the population in the vicinity of Indian Point is that the communities include people who do not understand or speak English. Messages need to be targeted to the various major ethnic groups to ensure that the warning is understandable. This issue of communicating with minority populations has been an issue in a number of emergencies. During the 1989 Loma Prieta earthquake, emergency services tried to provide emergency information to the Spanish-speaking community using Spanish-language media. But, there were a number of operational problems.[170]

There is guidance (Guidance Memorandum 20, October 19, 1983) jointly issued by the NRC and FEMA that mandates foreign language translations of public education materials. This memorandum recommends that if 5% of the voting age population of a county is foreign minority population, public information materials should be in the foreign language. The guidance memorandum lists the counties that met this criterion in 1970. The guidance does not address emergency information provided to the public during a radiological event. Of the four counties around Indian Point, both Rockland and Westchester counties have more than 12

[170] Federico A. Subervi-Vélez et al., Communicating with California's Spanish-Speaking Populations: Assessing the Role of the Spanish-Language Broadcast Media and Selected Agencies in Providing Emergency Services, 96 pp., November 1992.

percent of their population acknowledging that they do not speak English very well (2000 Bureau of Census data). Orange County has 8% of its population stating that they do not speak English very well (Putnam County includes 3.6% of similar population).

There was uncorroborated discussion during the course of this study that a number of people cross over from the City of New York to Westchester and Rockland counties to work in area residences and businesses. These workers may not have access to media outlets while in those counties and may be delayed in receiving warning. In addition, many may speak English as a second language or not at all.

Based on our analysis, the Fishers Island population does not have the same level issue of concern with respect to transient, non-English speaking day workers. However, Fishers Island may want to consider ways to improve communication to transient non-English speaking visitors to the island in the event an emergency response is required. Since Plum Island is a federal facility with a relatively stable and controllable population, there is no language issue related to warning there. At present warning systems are confined within the 10 mile EPZ. The public's perceived need for information and warning is not so confined. For purposes ranging from trust in local authorities, to rumor control, to lessening unnecessary evacuation, serious consideration should be given to expanding warning capabilities beyond the EPZ. This is particularly true for readerboards on arterials.

There is a final point that is of great importance for both Millstone and Indian Point. Public warning is not just a technical process made up of sirens, tone alert radios, Emergency Alert Systems, and highway readerboards. Public warning is first and foremost a **social process**. People receive the alerts from the sirens, tone alert radios, and Emergency Alert System. They make conscious decisions to listen, tune in, and make note of the emergency message. Each person, based on his or her current situation, decides on the actions to take (or not to take). This is a social process. It is slow, personal, and cannot be taken for granted.

Public education before an event can ensure that people are ready to receive a warning message. Public education can make emergency messages more meaningful. However, some of the commonly used mechanisms to educate the public (brochures, calendars, and inserts in telephone books) are not very effective when used in isolation, rather than as part of a comprehensive approach to community education. The average citizen receives a large amount of unsolicited information daily and has developed relatively sophisticated means of shielding themselves from it. Emergency researchers have indicated strategies that increase the effectiveness of public education programs. These should be integrated into the public outreach efforts of both nuclear energy facilities and the off-site agencies that participate in radiological emergency preparedness for the region.

11.1.1.3 Evacuation Planning Base Data is not Integrated into Indian Point Plans, Training, Exercises and Public Affairs—PROTECTION

In the event of a release of radiation from Millstone or Indian Point, people would need to receive warning and assistance in taking protective action. Time is critical in such a response. People must be warned in time and shelter or evacuate in time to prevent being exposed to harmful levels of radiation.

Population databases provide information on how many people are in the region and where they reside. Evacuation time estimates provide the length of time needed to evacuate portions of the region. These two pieces of information are crucial for determining protective action strategies. Population databases have been used at both Indian Point and Millstone and are currently being updated at Indian Point. Evacuation time estimates have also been developed by both utilities and are currently being updated for Indian Point. Issues have been raised as to how often and how accurately the population estimations and evacuation modeling ought to be done. The issue of how frequently such studies should be updated is a local site-specific consideration.

The State of New York should consider the growth of the New York population in the respective areas around Indian Point and Millstone and raise concerns with the licensee if the numbers change significantly. Updating population or evacuation time estimates is straightforward and updates can be done for portions of the ten-mile emergency planning zone without doing an entire new study from scratch (provided an adequate baseline study is done on which to base the updates). Updates are not judged to be a significant issue for Indian Point since the existing planning and coordination mechanism with the State of New York and the counties can be used to affect them when required. The coordination picture is not as clear as related to updates for Millstone. The State of New York should review the process for affecting updates of the applicable population in the Millstone ten-mile emergency planning zone with the State of Connecticut. For example the ETE study for Millstone assumes a peak summer population for Fishers Island of 2500 people whereas current estimates are almost double. This would make a difference on ferry trips and estimated evacuation times.

The larger problem in the **protection** area at both nuclear sites is the disconnect between the population/evacuation information and the plans and response. Emergency plans for the counties and the State do not articulate strategies to protect people based on the population database and evacuation time estimates. During response exercises, there is scant attention paid to how many people are potentially at risk and how much time is required for evacuation. Specifically, strategies for protective action decision-making are not currently in the plans for the Millstone and Indian Point radiological emergency preparedness jurisdictions.

Timing is important in response but recommending the right actions is equally important. Safety requires the right actions by the public at the right time. Each radiological emergency can have unique aspects – the accident can be different, weather could be different, time of day and hence the pattern of population distribution can be different, etc. It is hard for the human brain to process these complex variables and arrive at the correct protective active decision for each contingency. However, as we note later, the experience from Chernobyl indicates that the right protective action decisions can substantially affect how much protection the public receives. In the case of Chernobyl, the protective actions recommended by some countries led to a 50% reduction in total exposures. In case of other countries, even though protective actions were implemented, there was no overall reduction in dose – the reduction was 0%. For accidents smaller than the catastrophic Chernobyl event, the decisions on protective actions can have even more dramatic results on the public's safety. There have been speculations that up to 90% of the potential dose from an accident can be avoided through timely and accurate protective actions[171].

[171] *Preparing for Nuclear Power Plant Accidents*, edited by Golding,Dominic et al, Westview Press, Oxford, 1995.

This is a significant issue that needs to be addressed at both Indian Point and Millstone. Humans cannot process the hundreds of variations and arrive at the best strategy. However, computers can. These estimates can be prepared at the time of an event – but, it would be better to develop these protective action strategies as a part of the planning process. The Indian Point and Millstone areas need to develop a series of protective action strategies for varying contingencies. In our experience, for a smaller, less densely populated area, several million simulations had to be run to develop a comprehensive set of protective action strategies.

It should be noted that developing strategies in advance does not mean their automatic application in a real event. Even when the assumptions that resulted in the strategy precisely match the real world conditions, that strategy (and those conditions) should be reviewed by decision makers before application.

One notable exception should be mentioned. During the 2002 exercise at Indian Point, Westchester county officials considered the evacuation time estimates for the site. Since the evacuation times had been calculated based on 1990 population data, they added a rough measure of time (an hour) to the previously calculated evacuation time and made protective action decisions based on that information.

The lack of documented, coordinated criteria could lead to implementation, coordination, and consistency problems in response. Observers at the full-scale exercise noted that there was more than one case where emergency managers or decision-makers unnecessarily argued about the correct protective action during the response. It appeared that inconsistencies existed in the understanding of what needed to be done with prison populations, for example. The best time to develop protective action criteria is not during the response to an accident for obvious reasons. The State of New York should give strong consideration to upgrading plan content, training activity, and exercising specifically in this area. Technology can help with definition and consistent implementation of protective action criteria both within responding counties and across jurisdictional lines. It is also possible to automate such decision criteria in order to take the interpretation out of the equation at the time of the response, and to speed the process.[172]

Indian Point, Millstone and the off-site communities currently have no technology to simultaneously consider population, radiological plumes, and evacuation. If people are at risk, there will be a finite time window to protect people. This window may be larger in the case of a slowly evolving event. The window will be narrower, in case of a fast breaking event. Regardless, it will be finite. Planning and response both need to consider this time-bound nature of protection.

The off-site emergency plans at counties and the State do not include information on the time component of response. There has been little evaluation of how to best protect people under varying release scenarios. While decision support tools to calculate the best ways to protect people are not commonly used, they are available. These decision tools need to be incorporated into planning and response at both Indian Point and Millstone.

[172] IEM has specific experience in this area as related to response to releases of hazardous chemicals. The principles are the same and would be potentially applicable for response to radiological releases as well.

IEM performed a rudimentary analysis of the time-based protection issue for the 2002 full scale exercise at Indian Point. It indicated that a few emergency response planning areas in the region received the first indication that something was wrong from half an hour to two hours or more before the radioactive plume first arrived at the emergency response planning areas. Health effects are not expected when the plume first arrives; there must be sufficient time for exposure before health effects are expected. Despite these caveats, the half hour to two hours probably does not provide enough time for the warning to disperse through the community and for the protective actions to be completed. What is equally significant about this observation is the fact that this crucial point is not noted in response exercise reporting for Indian Point, a fact that reflects poorly on the efficiency of the exercise process. Likewise, IEM could not find any quantitative observations of this type in the Millstone exercise reports. Based on this fact and the lack of any specific protective action criteria in the Fishers Island or Suffolk County emergency plans, it appears that the lack of time-based protective action decision-making is an issue equally applicable for Millstone.

A key question that the counties and state are currently dealing with is whether or not the evacuation time can be reduced by directing traffic on major roads to flow in an outbound direction only. Such a strategy allows, for example, all lanes (normally both directions) of an interstate to be used "one way" to evacuate people out of the hazardous zones to safe areas. The issue thus far is debated in terms of the resources required to control traffic, and the likelihood of traffic accidents and/or citizen non-compliance with directions. This issue needs to be considered in the wider context of people protection and time available for taking protective actions. There are risks associated with making all lanes move in one direction. It would be necessary to determine whether those risks are higher than the risks associated with slower evacuation and potential exposure of the population to harmful radiation effects. We were not able to evaluate any current quantitative information that would help with a decision on this point because it does not appear to exist in the Indian Point or Millstone planning bases.

A related protection issue that is not directly associated with evacuation is the use of potassium iodide (KI) tablets. There are perceived safety risks associated with distributing potassium iodide tablets, such as the danger of anaphylactic shock and the need for reduced dosages for children. There should be an expanded public discussion and education concerning the benefits to be gained from potassium iodide distribution and whether that benefit is commensurate with the risks. Sufficient information already exists in the public domain for politicians, emergency managers and members of the public to make informed decisions regarding KI distribution planning and usage. For example, the NRC (http://www.nrc.gov/what-we-do/regulatory/emer-resp/emer-prep/potassium-iodide.html) has extensive information regarding KI in emergency planning. The FEMA website also has information regarding KI, including the Federal Policy on Use of Potassium Iodide (KI) (http://www.fema.gov/library/not02367.pdf). The information can be used in the public forum to make decisions. Public confusion has existed because the state and the counties did not collectively pursue such an effort prior to the widespread distribution of KI.

Aside from evacuation and potassium iodide, there are other alternatives to protect people. Sheltering is a proven protective action option, and it is included in the Indian Point emergency plans. However, these plans do not appear to address the effect of weather patterns on the effectiveness of sheltering. Sheltering effectiveness against absorbed dose is very sensitive to weather conditions such as rain. Sheltering times can be limited when the outside temperature is either very hot or cold because the cooling and heating systems should be shut down. Also, with certain kinds of radiological releases and in structures with some common construction materials, sheltering is not really effective in reducing dosages. Long duration releases, especially where large amounts of radioactive material are released over a long period of time, are not good candidates for sheltering. Sheltering has other implications as well, such as the need to consider placing KI and respiration filters in homes and offices, and to consider the expansion of delayed public transportation and of personal and vehicle decontamination capabilities.

Specific guidance on sheltering strategies or implementation was conspicuously absent from the Suffolk County plan and the Fishers Island plan. The Plum Island radiological emergency preparedness plan did cover this protective action option.

The discussion thus far has considered people as a homogenous, shapeless mass. When we separate the various types of population groups, other issues emerge. Protection of children is of greater emotional relevance to people than any other group. School plans demonstrated at the Indian Point exercise include the concept of evacuating children from the region *before* parents are notified. Researchers have documented the fallacy of such an approach: parents will attempt to go to schools as soon as word reaches them of a significant emergency[173]. Such actions may hinder the evacuation of most children, raise the level of congestion on roads, and lengthen evacuation times.

The only applicable school plan in the Millstone ten-mile emergency planning zone is for the Fishers Island school. The planned evacuation of this school, if required, is not subject to the same concept of operation problems as with Indian Point counties. The Fishers Island school population will evacuate via ferry with the rest of the island's population.

Like other communities, the area surrounding both Millstone and Indian Point contains many special need populations. At Indian Point, the emergency plans call for school bus drivers to collect these individuals and evacuate them after they have evacuated school children. However, if the event is fast breaking and the time window for action is narrow, there may not be sufficient time for the school buses to make this return trip to pick up special needs individuals. There are many issues with how many buses are needed or available and how many trips each would make. There is also concern that bus drivers may not return to the “contaminated”[174] area after

[173] The intentions of parents have been catalogued in a few studies. Nasar and Greenberg (Naser, L.J. and Greenberg, L.M., 1984. “The Preparedness and Reactions of Citizens to Warnings and Crisis Relocation for Nuclear Attack”, Journal of Applied Social Psychology, Volume 14, pp. 487-500) documented that 55% of parents plan will definitely or probably pick up their children from school. This study reviewed issues associated with nuclear attack. Approximately 37%of the parents said that they would definitely pick up their children; approximately 17% said that they would probably pick up their children from school. A survey conducted by Eliahu Stern (Stern, Eliahu, 1989. “Evacuation Intentions of Parents in an Urban Radiological Emergency”, Urban Studies, pp. 191-198) in Israel in 1986 found that a total of 66.6% of parents declared their intention of picking up their children from school in case of a radiological emergency at a power facility. IEM is currently conducting surveys at some chemical weapons stockpile sites in the United States. Preliminary results indicate that a minimum of 34% to a maximum of 79% of parents at chemical weapon stockpile sites state that they are very likely to likely to pick up their children from school. At three of the chemical stockpile sites, the number of parents stating that they are very likely to likely to pick up their children is 73 to 79%. At one site, in Oregon-Washington, the number of parents declaring such intentions is only 34%. Most of the credit for this could be ascribed to the very aggressive public outreach campaign at this location to convince parents to allow children to be protected expeditiously by the schools. All of these studies catalog stated intentions. All intentions do not translate into actual behavior.
[174] The perception of contamination will work in the same way as if the area is in fact contaminated with deposited radioactive particles.

evacuating the first wave of people. Emergency plans need to be based on the best available estimates of how people can be expected to behave in an emergency—not how emergency planners would like them to behave. Even though it is hard to predict how people will behave during emergencies, there is over fifty years of valuable empirical literature in the United States on this issue that can and should be integrated into planning and response. As with the previous point made on school populations, the evacuation plan for Fishers Island does not deal with special populations in the same way as the Indian Point radiological emergency preparedness counties. All of the population of Fishers Island evacuates the same way using the same resources. Plum Island does not have any resident special population. Any employees with special needs are accommodated in the existing response plan.

Westchester County should reconsider the policy on commuter trains once an emergency action level has been declared. Currently Westchester County stops the trains outside the ten-mile emergency planning zone immediately upon a plant declaration. The rationale is understood since the trains run close to the Indian Point facility as they travel upriver. But there is a balancing evacuation resource need that demands attention. Trains are a significant transportation resource, especially for transient workers or visitors that use trains to get into the ten-mile emergency planning zone. Procedures could be developed to make use of these trains to be ready to help clear people from the southern part of the emergency planning zone if the plume was going north, for example. Solutions such as allowing the trains to operate in a portion of the ten-mile emergency planning zone are complex in terms of coordination and parking (for people that drive to the trains), but they have potential for significant protection payoff if orchestrated correctly.

Similar considerations related to possible use of rail do not impact the New York populations in the ten-mile emergency planning zone for Millstone. Fishers Island plans to use ferries that can potentially be augmented by other watercraft to evacuate people to Stonington, Connecticut. Contingencies are in place with supporting agreements for the use of Plum Island waterborne transportation to help with evacuation of the Fishers Island population.

The use of watercraft on the Hudson River for evacuation within the ten-mile emergency planning zone for Indian Point was once considered and rejected. There are ferries to the south of the Indian Point ten-mile EPZ that could potentially be used, as well as scheduled river traffic, such as tour boats, that have significant capacity. The county and State planners should reconsider the river alternative as a means for evacuating specific populations (some have suggested school populations) and as a means to relieve some of the burden on the road network, particularly in areas identified as having the potential for rapid congestion. The increase in communications and coordination requirements to effectively use watercraft in this manner could be offset by faster clearance times for selected Emergency Response Planning Areas.

There is widespread lack of information about family emergency planning in the Indian Point and Millstone counties. Disaster research has shown a clear connection between family plans and increased penetration and saturation of public information associated with a hazard. In addition, researchers have found strong links between family emergency plans and social behavior in response. Families that have plans tend to take faster, more deliberate action in response to the emergency, and in response to emergency services instructions. Other disaster research has shown that family plans can reduce the role conflict for emergency services workers; they are more likely to perform their duties if they have earlier engaged in family protection planning with their families.

In some communities, such as South Hampton, a special facility for family members is established near the EOC, and is designed to accommodate the families of those expected to work at the EOC. This example of considering the family needs of first responders is worthy of emulation.

Small business and industrial planning is equally important to address the public safety considerations for employees and transient customers. In contrast, small business and industry plans are not really a consideration for Fishers or Plum Islands. It is acknowledged that both individuals and businesses have a responsibility to plan and thereby help themselves. In other words, it is not the responsibility of each county emergency management agency to develop plans for these individuals and groups. However, the county and even the State can do a number of things to encourage and even directly facilitate development of both family and business plans for radiological emergency preparedness. One "best practices" example that has been implemented outside New York is the creation and maintenance of an interactive website that walks an individual or business through the creation of a plan and allows an actual paper plan to be printed to share with family members or employees.

11.1.1.4 There are Serious Issues with the Response to Information Needs

The public information available has many shortcomings in content and quality. Because of this, the current materials are limited in their effectiveness in helping the public to understand the risk, how to prepare for an emergency, and how to respond to an emergency.

In general, the inadequate quality of public education also calls in to question the effectiveness of the existing outreach activities. Publishing and distributing an emergency booklet is an important step, but the limitations of this vehicle should be acknowledged and the approach supplemented. Of those that do receive the booklet, many will ignore this information. Others will lose the booklet, meaning that evacuation maps and other pertinent information such as the locations of the School Reception Centers would not available to them during an emergency. Furthermore, there may be an underlying psychological barrier which is diluting the public's receptivity to the information, regardless of its form. Several of the contacts at the county level expressed the concern that the public is distrustful of all sources of public information. They do not trust information coming from the County officials, State Officials, or Entergy. Our interaction with the public confirmed that this distrust is widespread and that the quality of public education is low. This indicates that efforts to date have not been effective.

Our main concern is that this distrust impacts the workability of emergency response plans. It is ultimately individual decisions which dictate the public's behavior in an emergency situation. If the public does not trust the information being given to them about what they should do in the event of an emergency, they are more likely to disregard the procedures laid out for them in the emergency response plans and presented to them in the emergency response booklets. They will make their own decisions about when to evacuate and how they should reunite with their family;

their actions may not be in line with the prescribed plan and may jeopardize their health and safety and that of others as well.

11.1.1.5 There are Serious Issues with Communications Among Emergency Personnel—COMMUNICATIONS

Communication is the lifeblood of emergency response. We noted a number of communication problems at the Indian Point site. There are problems with communications interoperability and connectivity, especially in the more hilly Orange and Rockland counties. In fast-breaking events, these communication channels will need to carry more traffic. In addition, there were a number of smaller communications problems observed at the Indian Point full-scale exercise that are not serious in themselves, but cumulatively have a significant impact in an emergency. Even the inability of many of those in the JNC to communicate using cell phones can become in a real event more serious than a minor nuisance to the media. Much of the analysis that supports the conclusions on communication needs comes from historical and anecdotal information, as well as expert judgment of personnel both affiliated with and external to the Indian Point radiological emergency preparedness jurisdictions. Communications issues appear to be less pronounced for the Fishers Island and Plum Island populations, especially given the redundant systems in place. The picture is less clear for Suffolk County because of the absence of a REP plan and an exercise to physically observe. Based on the county's communications SOP, it appears critical communications between the county, Millstone plant and the two island populations are adequate. We do not have strong evidence of strengths or weaknesses in the inter- and intra-county aspects of Suffolk's communication capabilities.

There is not enough stressing or loading of the communications system in the full-scale exercise to clearly show the systemic and interrelated nature of the problems that are predicted if a real radiological accident were to occur. Particularly absent is an effective test of the interaction of the public once an emergency is declared, with the resultant impact on phone lines, cellular circuits and even the Internet. This type of test in a full-scale exercise is probably impractical. However, there is enough evidence in the literature and an adequate number of case studies on communications disruption in emergencies to defend this conclusion that these problems can occur at a radiological event involving either Millstone or Indian Point. Direct observations were made—supplemented by interviews with emergency services personnel—of a number of interoperability issues among responders, as well as some related to crossing government boundaries when using radio communications.

The interoperability issues that were captured are not unique to New York. They exist at local and state levels all over the US. Unfortunately, the impact of the communications problems is often learned after a disaster strikes. The State of New York can help its radiological emergency preparedness community avoid this type of “learning” through aggressive identification of communications connectivity and interoperability issues, prioritization of solutions, and oversight of implementation of the solutions. There is also a critical need for design and implementation of a better testing mechanism to stress communications and provide the critical feedback loop on how well new solutions address the problem.

Recently the four Indian Point radiological emergency preparedness counties proposed a regional partnership approach to a dedicated wireless network. This is a step in the right direction.

Communication upgrades generally take years for design, implementation and testing. It is important to move expeditiously to implement effective, interoperable communication systems linking all principal first responders and response elements. The State of New York's support for this dedicated wireless concept and assistance in making a pilot happen quickly would be an effective start to the oversight process already described.

11.1.1.6 Issues with Planning, Training and Resources Will Need Corrective Action in Order to Improve Preparedness

It will be difficult for the State of New York to effect large scale improvement in a number of the critical preparedness areas discussed above without attending to the root cause areas of planning, training and resources. These areas form the foundation for successful implementation of warning, protection, and the other response processes—and they are connected just as the response processes are connected. They cannot be viewed and prioritized as a set of individual components that need to be corrected. Otherwise, unintended consequences, perhaps more severe than the problems "fixed", will undoubtedly result. To truly fix preparedness shortfalls will in most cases require attention in all three of the root cause areas. In addition, a connection must be made to the exercise function since it provides the only relevant way to test the fix in operational practice.

The Nuclear Regulatory Commission has developed a formal root cause analysis and corrective action process for the licensee, but there is no equivalent process used in the off-site radiological emergency preparedness communities. Formalization and implementation of such a process would allow the State of New York and the other off-site jurisdictions to deal with preparedness in a systemic manner rather than as a laundry list of individual problems. A root cause analysis process would further allow the State to determine the necessary linkages in activities necessary to fix a preparedness problem and to determine the cost of the fix in terms of time and resources. This information can in turn be used to prioritize and build a work plan for improvement year to year.

Within the cornerstone framework, the NRC uses both performance indicators and inspections to verify that all facility parameters are as they should be. Performance indicators are reported by the facility and measure critical items. The NRC supplements these with a rigorous regime of inspections. If inspections find any issues, the facility must conduct a root cause analysis to determine the factors that led to the problem. A root cause analysis is a structured quality activity in many industries. The root cause analysis acknowledges that problems may be evident on the surface but their real reasons may lie far away from where the symptoms are evident. The NRC inspects the root cause analysis conducted by the facility on problems identified during inspections. If there are a significant number of cornerstone issues that show degradation, the NRC conducts supplemental inspections. NRC inspectors are trained in root cause analysis techniques.

There are a number of emergency planning issues identified in this report and in the response process areas previously discussed. They do not need to be repeated here. The other aspect of planning is development of a work plan—how to go about fixing the issues. There does not appear to be a sufficient formal plan to address radiological emergency preparedness issues raised for Millstone or Indian Point communities, perhaps because there is no strong regulatory demand or other incentive to build one. The findings of this report should provide enough evidence that the incentive is the need for improvement.

Training for both the licensees and the off-site radiological emergency preparedness emergency managers appears focused on individual functions or functional areas. The linkages between functions and to the larger response system are not typically addressed in training. In addition, there does not appear to be a mechanism to specifically evaluate the impact of training on outcomes in exercises or even actual events. Without this critical feedback loop, there is no effective way to determine whether the right training is being conducted and specifically how it can be made better. Based on the review of Indian Point and limited review of Millstone training activity, the final component that needs additional attention is localized training for specific operations during a response. Radiological training for ferry crews that provide the means of evacuation for the Fishers Island evacuation, evacuation route training for bus drivers around Indian Point, and family protection planning training for school teachers are examples of needed localized training. Localized operations for the licensee personnel are generally well-defined and the personnel are trained. Jurisdictions need to identify off site local training shortfalls and put greater priority on addressing them.

Despite the more rigorous licensee focus on training, a site-specific NRC inspection report for Indian Point (April 10, 2001 FAT report) notes that the licensee could not correct deficiencies found in exercises. The corrective actions focused on conducting an annual exercise, post-exercise critiques, and lessons learned. However, the actions did not include an assessment of the effectiveness of training for resolving these issues, qualifications of the responders, or lessons learned from discussions with affected individuals. Such critical links between training and the other foundational areas and response processes need to be identified and integrated into the exercises to ensure the right type of training with the right impact is being applied to achieve the right outcome.

Personnel and materiel will need to be focused to accomplish improvements in preparedness in the Millstone and Indian Point radiological emergency preparedness communities. Application of the additional resources may involve adding people or equipment to organizations or may involve use of people and equipment that have other conflicting day to day duties and responsibilities. In either case, application of the resources will represent a cost to the organization. We know stakeholders will need to prioritize the issues in terms of resource availability or limitations. The State, counties and licensees do not have unlimited people, time or dollars to implement improvements everywhere issues have been noted.

Particularly important is the point that it may be difficult to define an improvement work plan and assign appropriate resources when there is still a question of whether or not the correct level of resources is available to perform critical response activities. The radiological emergency preparedness exercises simply do not challenge the resource component of the response enough to provide an understanding in the off-site community of where the resource shortfalls lie. When such insight surfaces, it tends to be focused on a single functional area, such as a school or a particular aspect of traffic control. Using the FEMA system it is difficult for the emergency managers to determine the **systemic** resource shortfalls. The evaluation of resource availability and capacity needs to be done in the context of performance outcomes, and the resources must be challenged through different types of scenarios in order to project whether or not their planned use will be sufficient. It was difficult in this study to determine specifically whether a given organization or plan possessed sufficient resources to perform critical response activities based on a lack of such performance-based outcomes.

The licensees, through their stringent regulatory basis and increased number of drills and training opportunities have a reasonable level of confidence that they have the right number and type of people to conduct a response. In fact, staffing levels are provided in NUREG-0654. The off-site communities have no equivalent basis on which to judge personnel or equipment. This fact points to a need for an emergency management staffing study and associated capabilities assessment for the off-site radiological emergency preparedness jurisdictions. If the State of New York can establish a baseline for required resources, it will be easier to link resources to plans and test resource outcomes in the exercises. Without such a radiological emergency preparedness resource baseline it will be more difficult to identify, prioritize, and implement improvements against perceived resource shortfalls.

11.1.1.7 Improving Preparedness Will Require a Move Away from the Compliance Mindset and Functional Area Basis for Evaluation

Chapters 8 and 9 provide a clear argument for the advantages of a "systems view," or "systems-of-systems view," of radiological emergency plan improvement versus the compliance view driven by the existing regulations and plan evaluation processes. The fundamental premise is that compliance in itself, while allowing all the "boxes to be checked," does not guarantee public safety outcomes. It is our belief that the New York radiological emergency preparedness plan can only address this public safety bottom line by defining measures and standards for the outcomes and evaluating the system in a way that answers the preparedness questions in terms of the desired outcome (where a standard exists, measures need to be defined in terms describing desired outcomes). Trying to satisfy the bottom line public safety questions in terms of compliance will not result in reliable answers. The compliance points are abstracted too much from the end point (public safety outcome). Another way to say this is that complying meets the letter of the preparedness principles and practices outlined in a document like NUREG-0654/FEMA-REP-1, but does not necessarily meet the intent.

The radiological emergency preparedness exercise program tends to focus on evaluation of the functional parts of the system much like a compliance review of plans requires. Individual functional areas are evaluated and the performance of the functions in the response is graded. The grading is largely subjective, although the Nuclear Regulatory Commission does provide some objective measures in the evaluation of the licensee. With no direct objective links to the performance outcomes of the response system, the cause-and-effect relationship of the function to the outcome cannot be established. The grading within a functional area can be accomplished with great rigor, and it may be quite effective in evaluating the function. It cannot guarantee that the desired system outcome was achieved or even addressed.

There is another disadvantage of a functional basis, even where objective metrics are applied. The functional mindset creates performance metrics for some parts of the process but not other parts, or creates the metrics without consideration for the larger system outcome. This type of approach can lead to measuring what can be measured rather than what is harder to measure or most important to measure. The Nuclear Regulatory Commission inspection report for a June 1998 exercise captures the need for a shift in both mindset and best-practices. According to the report, "Objectives are to be observable, measurable and describe the appropriate response so that evaluators … can objectively assess performance." Therein lies the fundamental problem. Observable behavior is not the only issue. Even more important is the determination of whether or not the population is adequately protected an outcome that is not directly "observable" in isolated functions performed during emergency response exercises.

11.2 Recommendations

JLWA and IEM have seven recommendations for the Indian Point and Millstone emergency management systems. In brief, they fall into the following six categories:

Planning	Planning should be improved to take into account expected human behavior and should identify strategies to protect people under a variety of circumstances, including fast-breaking events. A key part of this planning effort should be a series of region-wide workshops to agree on a set of performance measures for nuclear emergency protection.
Expansion of Circle of Planning	The "circle of planning" should be expanded to include special facilities, large employers, and the public in the region, out of recognition that emergency response involves a host of actors.
Public Outreach	A comprehensive public outreach strategy should be put in place to better educate all sectors of the public on their role in emergency response plans.
Training	A comprehensive training program should be put in place for managing a nuclear power plant event. This should include certification of some key positions involved in response.
Exercises	Exercises must be improved with a focus on performance outcomes. Lessons learned from the exercises should be integrated into emergency management.
Communication	Communication systems linking emergency personnel should be rapidly upgraded. The goal needs to be a seamless, fully interoperable communications system, among all the involved jurisdictions.
Technology	Better technology should be evaluated and integrated into response management.

These elements are discussed in more detail in the following sections.

11.2.1 Improve Planning for Nuclear Power Plant Emergencies

Rigorous and realistic planning can help to respond better during an emergency. The improvement cycle for emergency preparedness in the area around nuclear plants must start with better planning. Some recommendations for improving the planning process are outlined below. Many will note that our recommendations for evacuation planning and other aspects of emergency management are not confined to the 10 mile EPZ. It is important not to extrapolate from what we have said to what some would like for us to say. To plan for spontaneous evacuation both within and beyond the EPZ, for example, is not the same as planning for evacuation beyond the EPZ. The effects of a release generally decrease with distance, and the time for protective measures increase. Considering the limited resources available, there is more urgency to improving the planning and associated activities within the EPZ than there is to expanding those activities beyond what was earlier established as the area of need. Our opinion on this issue may change based on further scientific review now being performed.

11.2.1.1 Community Process to Agree on Performance Measures for Safety Outcomes

Many groups and officials have expressed a concern about the emergency management system in place around Indian Point and its corresponding impact on public safety. Even though Millstone experiences a generally lower level of advocacy, concerns are also voiced for that plant. In this regard, a number of the recommendations to be discussed later in this report are focused on upgrading the capabilities of the emergency response system—addressing the "objective" safety from radiation hazards. Many of these recommendations involve a shift from a compliance-based emergency response system to a performance- or outcome-based emergency system.

A shift to a performance-based system should improve communications between advocacy groups and those responsible for planning, because the former talks in terms of outcomes now. It is possible that with improved communication, or at least a common vocabulary, the tension between those involved in emergency planning and the advocacy groups might be reduced. That is a goal worthy of pursuit; both groups should be able to agree that public safety is their primary concern. As both may also agree that public education furthers public safety, there is even room for cooperation in this important area. The onus is not all on emergency planners to recognize the validity of advocacy groups' focus on performance outcomes, however. Advocacy groups use language whose emotional content can increase unnecessary evacuation, and thus can have adverse consequences for public health in the event of a release. As in the case of CRAC2 (discussed more fully under Limitations and Omissions in this chapter) their persistent misuse of scientific data contributes to public misinformation. Ending those parts of their effort that can with fairness be termed demagoguery would serve the public better, and make more effective the participation of advocacy groups in the region wide planning process we recommend immediately below.

A shift to a performance based system, though it provides information on how much safety the system is capable of providing, will not resolve deep-seated differences among stakeholders regarding how much performance is desired from the system. Therefore, we recommend a region-wide process that engages key stakeholders in determining what performance outcomes are desired from the system. These stakeholder meetings should be held in all parts of the region. The meetings should include discussions of hazards that should be included as a part of the accident planning base, the extent of protection to be expected from emergency management, and how and how often tests should be conducted to test capabilities. This effort might most naturally be led and coordinated by the New York State Disaster Preparedness Commission.

It is appropriate to mention here that a vast number of issues were surfaced in our review by people who believed their treatment in the plan(s) was missing or inadequate. Among those issues are many we have done no more than mention in this report, such as: as warning and protective measures for those in after school activities; finding bus drivers after hours; accounting for day cares with three children or fewer; “latch key kids”; evacuation routes that go past Indian Point; accounting for seniors who live alone; multiple reception centers for a single family; major events at West Point and/or Bear Mountain; evacuation recommendations while kids are on the way to or from school; inadequately equipped reception centers; conflicting bus company obligations and/or shortages of buses; warning and protective measures for summer camps and backpackers; etc. We believe that if our recommendation for broadened planning participation is adopted, a recommendation that applies to both plants, then these issues will be thoroughly considered in the appropriate forum.

Similarly there were some issues we may have touched but did not make definitive recommendations on because of the need for location specific considerations. For schools alone such issues include allowing parents a window of time to pick up school children before the buses arrive; facilitating neighborhood arrangements for the pick up of school children; the adequacy of phone chains for alerting school superintendents; considering the construction of an over pressurized facility within schools near to the plant; and stationing buses nearer the schools they might serve. Broadened planning participation would help explore these issues as well and allow the best mix of strategies for each ERPA.

It is important to note here that we are not saying all these planning considerations need to be in plans or response operations to make them effective. What is important is that the broadened planning community consider them in the context of the risks and their viability from a resources standpoint, then make an explicit decision as to what will be addressed and how. The planning community must further be willing to articulate to decision-makers and their public those things that will not specifically be accommodated in planning or response, and why.

The area around the Indian Point site is perhaps the most densely-populated of any nuclear power plant in the United States. The NRC standard, minimizing the radiological dose to the public for a spectrum of accidents, is harder to achieve in such an area. The State of New York should request that FEMA and the NRC develop unique performance requirements in recognition of the special challenges posed by population density and the larger number of people who may be at risk. It is prudent to have higher requirements for emergency management in this region as compared to less densely populated regions.

Because the above conditions are not equally applicable to the New York area near the Millstone plant, our recommendation above applies only to Indian Point.

11.2.1.2 Realistic Expectations of Public Behavior Must Underlie Planning, Response and Public Education

Disaster researchers have compiled a large store of information on how the public in the United States responds to various disasters. Although data on nuclear events is understandably sparse, there is information available on how people may respond. The current planning assumption, that the public will not act in ways that will compromise the effectiveness of the response, can lead to serious miscalculations. Planning, response, and public education all need to take into account the general findings of disaster researchers on how people behave during emergencies as well as specific findings from the region on the expected actions and intentions of the people living and working around both nuclear facilities, both within and outside of the 10 mile EPZ.

The public behavior calculus should also include the special concerns of the people in New York. Having lost many lives in the 9/11 tragedy, they may be especially vulnerable to concerns about terrorism; accordingly, their behavior may be markedly different from what may be expected at other regions and locations. Therefore, we recommend that:

1. A compendium of knowledge on public behavior during emergencies be compiled to inform planning, response, and public education.
2. A baseline public opinion survey on the knowledge, intentions, and expected behavior of people during an incident at the Indian Point and Millstone facilities be conducted. This survey should be repeated at intervals, not longer than two years, to note any changes in the public perceptions or expected behavior, including the effects of public education discussed elsewhere. The survey should not be confined to those within the 10 mile EPZ because there are significant health and safety issues related to public behaviors beyond that zone.
3. Plans be developed to include variations in public behavior. A sensitivity analysis should be conducted for each portion of the plan that involves public behavior, and where substantial uncertainties exist on how and when the public may behave.
4. Exercises be held that specifically test for the ability to integrate public behavior into response. To be effective, emergency managers must take into account what the public will do, and exercises should emphasize this pragmatic realism.

11.2.1.3 Strategies for Protection of People Must be Developed for Many Contingencies

Current emergency plans for the Millstone and Indian Point regions articulate strategies to protect people, such as evacuation or sheltering. However, these strategies have not been verified or validated.

It is not practical to evacuate large regions as a practice test to gauge the time and congestion such an evacuation would cause. Modeling and simulation is one of the few ways to validate the effectiveness of emergency management strategies. The Environmental Protection Agency conducted such modeling for determining the effectiveness of nuclear regulations at the national level and for planning a regulatory scheme. However, the national-level modeling used average data, not representative of any specific region or plant.

A similar level of sophistication is needed to plan for the protection of people in the area around Indian Point and Millstone. More comprehensive and capable modeling suites are now available and should be employed to develop the best possible technical and scientific basis for the protection of public health and safety around both facilities.

The entire gamut of protective action strategies should be considered simultaneously, something not possible without the use of modern technology. Evacuation, sheltering, administration of stable iodine, and washing and changing clothes are the principal protective actions. The current protective strategy at Indian Point is to evacuate; if evacuation is not possible, then sheltering is recommended. This simple “screening” strategy for determining whether to evacuate or shelter is inadequate. The implication is that if there is not sufficient time to evacuate everyone, then sheltering would be effective. However, there may be plant or weather conditions where sheltering would not provide the requisite amount of protection. It is less clear which mix of protective actions are intended for Fishers Island since sheltering strategy is not detailed in their radiological emergency preparedness plan. Nevertheless the same principles apply for that New York emergency planning zone population as for Indian Point.

It is not possible to combine the myriad of critical concerns in a complex nuclear emergency and determine the optimum protective action during an unfolding event. Time for decision-making will be short. Planning can improve the nature and effectiveness of response. Therefore we recommend that:

1. Information on the planning base for the region be compiled and updated. The planning base should have accurate and current information on population types by time of day, the evacuation network, and building structures (including their capability to block outside contaminated air). Some special populations may be at higher risk during radiation emergencies because of dietary habits, activity patterns, cultural practices or language barriers. The database should also estimate the number of transients and undocumented persons in the region.
2. Modeling studies be conducted to examine the optimal strategies for protection of public health and safety. These studies should examine many contingencies. The contingencies should vary the type of release, weather conditions, time of day, traffic congestion levels, public behavior, and other factors. These variations are necessary to arrive at robust and comprehensive solutions on how people can best be protected.

   The modeling for the Indian Point site should be very site-specific, using local plant parameters, population distribution, road capabilities, building structure characteristics, and expected local public behavior. The modeling should incorporate all protective actions simultaneously. Evacuation, sheltering, provision of stable iodine, and washing and changing clothes should all be incorporated to determine the best combination of actions to minimize exposure to radiation.

   The modeling should include both the initial plume exposure period and the later ingestion period, when exposure is more likely through the food chain. Ingestion issues are expected to affect a much wider area and perhaps have greater economic effects for the region. These concerns should be folded into the protective strategy modeling.

The modeling for Millstone should focus on the dynamics of Fishers Island and Plum Island, and other areas local authorities believe are of concern because of the direct or indirect effects of a release.

3. Once protective action strategies have been determined through modeling, the State and county emergency planners should develop action plans to implement these strategies. These action plans should include consideration of resources needed to implement the strategies. If school children will be evacuated using buses, there should be letters of agreement on file with bus companies to ensure that buses will be available. A coherent approach to stockpiling and distributing potassium iodide should be developed by the State.

   A radiation emergency at Indian Point or Millstone will be a significant disaster for the nation, especially if it involves terrorism. The action plans and resource allocation should consider federal resources that may be available. The action plans must consider not just the availability of federal resources but also carefully consider the time frame in which such resources may become available. All resources (federal included) that could be expected to be deployed should be included in exercises periodically to ensure that they will be available as expected, with appropriate resources.

   As decontaminating people potentially exposed is one of the protective action strategies to be deployed, the State and counties should carefully model and consider if the current number of decontamination units is sufficient, and whether their location is wise.

   If school children are to be evacuated, pre-staged evacuation kits containing clothing, medicines, and other special articles should be positioned at schools. Plans should reflect procedures for periodic inventory of these articles.

   If evacuation time estimates show that evacuating people from the region over land takes too long, consideration should be given to the use of trains, boats, and other transportation modes to evacuate people faster.

   If evacuating people south is difficult because of spontaneous evacuation, and from west to east is difficult because of the road system, then evacuating north should not be rejected because it involves yet another county.

4. Mutual Aid Agreements should be executed between counties and support agencies and organizations. Such agreements may be with surrounding jurisdictions, with private entities, or between "at risk" counties. In general, a number of these types of agreements have already been executed by the counties. Existing agreement should be revised and expanded to cover new strategies and the possible increased participation of support agencies and organizations

11.2.1.4 Medical Preparedness Needs to be Upgraded

In case of a radiological emergency, many people can be expected to show up at hospitals and medical facilities. In the sarin attacks in Tokyo in 1995, 5-15 times the number of people actually exposed showed up at hospitals fearful that they had been exposed. The medical systems at the Indian Point and Millstone regions are expected to be taxed with both treating those that are exposed and dealing with a large influx of people that are "worried well." Others will want KI or to be where the doctors are, where it is safe.

We recommend that the medical facilities be engaged in the processes of planning, training, and exercising to a much greater degree. Biological preparedness studies have sounded many warning notes on the capability of the current medical system to respond adequately to a large-scale disaster. Although a radiological event at a nuclear power plant is dissimilar in the nature of the burden it would impose, many of the solutions for medical preparedness against nuclear events may synchronize well with biological preparedness.

11.2.2 Expand the "Circle of Emergency Management"

In case of a radiological emergency associated with Indian Point, a wide range of individuals, organizations and public bodies will need to take emergency action. The actions of these organizations, jurisdictions and people will spell the difference between many people protected and many exposed. We recommend that the "circle of planning" at the Indian Point region be expanded to include cities, towns and villages, special facilities, large area employers, and the public. Westchester County's five Emergency Response Plan Focus Groups for education, health, transportation, public safety and communications is a good move in this direction. While this issue of stakeholder numbers is less pronounced for the New York population in the Millstone emergency planning zone, the State and County should consider where selected implementation of the same strategy would assist. It is worthy of mention that the likelihood of effective response at the local and facility level is enhanced if the chief elected official or CEO makes clear public or company policies regarding expectations for their key workers and emergency responders in time of crisis. That articulation of expectations is more likely as these individuals, organizations and public entities are brought into the process.

11.2.2.1 Cities in the Indian Point Area Need to Be Involved in Emergency Planning

As noted earlier, we use the term "cities" generically, recognizing that there is a relationship among Towns, cities and villages that is complex and not well known to many who will read this report. Cities are not principal players in the planning, training, and exercising at the Indian Point region. We recommend that cities become more involved in the response planning, training and exercising in the region.

Both Stony Point (Rockland County) and Cortlandt (Westchester County) have active cross-jurisdictional and cross-discipline response planning groups. They actively include private schools, public works, police, and other organizations in their response planning. Both the counties and the State should take a close look at assisting them and other similar ad hoc groups, perhaps using them as models.

This recommendation is not particularly applicable to either Fishers or Plum Island, but it is applicable to planning, training and exercising in Suffolk County.

11.2.2.2 Special Facilities Need to Plan for Emergencies at Indian Point

The Indian Point 10-mile and 50-mile emergency planning zones contain hundreds, and possibly thousands, of special facilities. Special facilities are any facilities that house (either 24/7 or for some hours of the day or night) populations that are either harder to warn, harder to protect, or more vulnerable to health effects from exposure. Special facilities include day care centers, schools, universities, correctional facilities, nursing homes, hospitals, assisted care living facilities, factories with high noise levels that would impede hearing of sirens, etc.

Jurisdictions should work more closely with these facilities to create a greater capacity for response. The problems and challenges of each facility will be unique and these concerns will need to be incorporated into planning, training and exercising. Facilities requiring long lead times to take protective actions may need to be warned sooner. Facilities may need planning resources or actions, such as weather-proofing buildings to protect in-house residents to allow for shelter-in-place, or obtaining transportation to evacuate at-risk residents. Such arrangements and resources will take time to put in place.

Again, this recommendation is not particularly applicable to Fishers Island or Plum Island. The State of New York may want to confirm that existing Fishers Island plans sufficiently accommodate the few facilities on the island.

In Section 8.1.4, we discussed the relative value of drills versus interviews in a vigorous exercise program. We used the interview process with Rockland County schools as an illustrative example. That discussion is applicable here too. Special facilities, and large employers (below), should consider the benefits of actual drills in the design of their exercise program.

11.2.2.3 Large Employers Need to Plan for Emergencies at Indian Point

There are many large employers in the Indian Point region, which is not the case for the New York portion of the Millstone ten-mile emergency planning zone. In case of an accident at Indian Point during working hours, employers will need to take response actions. Companies also face business continuity concerns in the event of a protracted event at Indian Point, especially one that might impact the public power supply.

The State cannot be held responsible for emergency planning for private companies. However, it can encourage, help, and/or train private employers to develop contingency plans for their employees, and business continuity plans for their operations.

11.2.2.4 Public Education Programs Need to Emphasize Family Emergency Planning

No emergency plan can function without the effective and timely action by the public that it is meant to protect. People are a vital part of emergency response planning. However, it is remarkably hard to reach people with emergency messages when there is no emergency.

Disaster researchers have found that public education can be effective if it is focused toward families building emergency plans for a variety of hazards. The State of New York, counties, and cities should encourage area residents to develop family emergency plans. These plans should be specific to each family situation—where they work, where they live, where children go to school.

In particular, the State, counties, and cities can encourage these family preparedness plans by assisting emergency responders with developing plans for their own families. Disaster researchers have found that development of such plans assists emergency responders in dealing with their own personal and professional role conflicts during events. It is in the public interest that first responders continue to perform their responsibilities rather than leave to take care of their families.

Public education on developing family emergency plans should be specific to population groups. The Indian Point region has population groups that do not speak English, do not ever tune into radio or television, and people that commute from one county to another and may not have access to general media while in another county. While Fishers Island has fewer of these issues, they are relevant for emergency planning in Suffolk County generally. Resort areas attract people speaking a variety of languages, and there are a number of domestic workers for whom English is not their first language.

The State, counties, and cities should use existing community structures, such as Parent Teacher Associations, neighborhood civic associations, non-profit community agencies, religious organizations such as churches, synagogues, and mosques, and other organizations to spread the message of family emergency planning. In association with this education, courses should be offered to interested groups on how to shelter-in-place effectively.

Public education of this magnitude is complex. However, the benefits lie not just in greater preparedness for a variety of hazards, including accidents at Indian Point or Millstone. The benefits also extend to a greater sense of control on the part of the citizenry—and an understanding of the vital role that they can play in their own protection.

11.2.3 Develop and Implement a Comprehensive Public Outreach Strategy

There is no evidence to suggest that increasing public knowledge of a risk has predictable results in swaying public attitudes either to accept or reject exposure to that risk. Proponents of nuclear power often assume that if the public were better educated on the full range of issues relating to nuclear power they would be less hostile to individual plants. But it is also possible that more education of the general public may actually reduce their willingness to accept the risks of a nuclear power plant. Our advocacy of enhanced public education assumes neither outcome. Instead it is based on the evidence suggesting that populations are willing to apply rational criteria to evaluate contentious issues[175]. We see a need for emphasis on public education so that the debate about the plant may rise above the emotional level. Moreover, it is our hope that the

[175] C.P. Wolf. *Public and Community Involvement in Preparing for Nuclear Power Plant Accidents*, by., Dominic Golding et. al., Westview Press, 1995.

recommendations below, if adopted, will help improve the quality of public education as a vital aspect of effective emergency response plans.

The State and the Counties have not instituted a *comprehensive* public outreach strategy which includes a variety of means for disseminating the necessary information. Several counties have taken the initiative to implement public outreach activities such as speakers bureaus and town hall meetings with targeted sectors of the population. The existence of these activities is encouraging and definitely a step in the right direction. However, these activities need to be incorporated in to a strategy. They need to be coupled with mechanisms for gauging the degree to which the public is absorbing the information presented, and should be adjusted to make sure that all sectors of the population have the information they need to participate in an emergency response.

A comprehensive public outreach strategy means implementing an ongoing public information campaign that makes use of a variety of media, is complemented by enhanced community outreach, and includes surveys and/or other measures of effectiveness. The strategy should include a clear definition of goals and desired outcomes, and should include input from all stakeholders including the State, Counties, Entergy, school officials, advocacy groups and others. Community outreach is a way of providing a forum for public dialogue which will help those who are responsible for emergency preparedness to better understand the public's concerns. These concerns can then be accounted for and, where appropriate, incorporated into emergency planning procedures and future information materials. Also, by supporting and engaging willingly in a dialogue with the public, State and County officials will offer a degree of transparency which will likely increase their credibility. Public outreach is not a one-time event. Habitual exposure to emergency planning may significantly improve public understanding, and thereby increase the workability of emergency response plans.

The additional recommendations below address some of the specific inadequacies noted in Chapter 7 in our review of the public information materials and public education program.

11.2.3.1 Regularly Survey the Public to Measure the Effectiveness of Outreach Efforts

Currently, the State and Counties do not have a clear understanding of the relative effectiveness of their current outreach methods or public information materials, or a way to target resources towards the most effective ones. Nor can they have a clear understanding of the populations which they have reached, and those that are under-served. Westchester and Rockland Counties are the most proactive in their outreach efforts, but we saw no evidence of a comprehensive campaign including a survey of effectiveness[176]. Regularly surveying the public will help identify populations where education levels are low and provide the State and counties with valuable feedback for improving their materials, delivery mechanisms and targeted outreach activities.

[176] Because of a reorganization of government, many of Westchester's records of their public outreach activities had been lost. Although we have no reason to doubt that these activities are going on, we were not able to comment on the diversity of activities, or question the public on their effectiveness.

11.2.3.2 Revise the Content of Indian Point and Millstone Emergency Booklets

As they are now written, the emergency booklets for both Indian Point and Millstone have some serious shortcomings in content. All omissions and errors noted in Chapter 7 should be addressed.
Below is a summary of the major recommendations that are relevant to both the Indian Point and Millstone emergency booklets:

1. Resolve issues regarding notification procedures in the emergency plan and then clearly articulate how residents will be warned. Highlight the procedure and protocol by which emergency information will be disseminated to the public during an emergency. This also entails identifying one authority figure who will be charged with communicating with the public during an emergency. Provide an emergency hotline for obtaining additional information when a siren is sounded, and highlight it in the emergency booklets. This number could lead to a recording that provides callers with information on the system and what to listen for, what to do if a siren sounds, whether a siren test is scheduled for that day (and what time) or that there was a malfunction.
2. Include a comprehensive discussion of sheltering and emergency situations in which it is advisable, especially in which sheltering is preferable over evacuation. This discussion should also include a discussion of the best ways to prepare a home or office for sheltering. Include tips on protective measures, which make sheltering more effective, and what types of buildings offer the best protection.
3. Address the issue of shadow evacuation in the evacuation section, and explain the potential harms of unnecessary evacuation.
4. Revise the section of the booklets on school evacuations. Include a more detailed discussion of the specific procedures and who will be taking care of children at every stage of the evacuation. Include details such as how children will be accounted for, who will be overseeing the evacuation, and what kind of training and preparedness efforts faculty and staff have received.
5. Discuss any possible side effects or dangers associated with improperly taking potassium iodide tablets.
6. Include a straightforward discussion of the health hazards of radiation exposure including additional information on avoiding radiation exposure and a description of each plant's radiation monitoring capabilities and procedures.
7. Provide a more in-depth discussion to support family emergency planning initiatives. Public outreach activities geared towards family emergency planning can then refer participants to the emergency booklets for instructions and more information. Include a discussion of the benefits of family emergency planning and provide examples of creative activities that area families have used. Discuss why emergency planning is important for all hazards, not just a radiological emergency. Provide a checklist of action items that must be completed for a comprehensive family emergency plan.
8. Provide large print and Braille versions of the emergency booklet for the visually impaired.

Specific recommendations for *Emergency Planning for Indian Point: A Guide For You and Your Family:*

1. Provide examples of events that correlate to each of the specific emergency levels.
2. Revise the section on school evacuation procedures to reflect the emergency response plan. Parents should know that their children may be moved to a congregate care center.
3. Consider public beliefs and make the statement about Three Mile Island more credible.

Specific recommendations for the *Emergency Planning at Millstone Station: A Guidebook for Our Neighbors*:

1. Include a section on family emergency planning.
2. Address the concept of radioactive plumes in the radiation section.
3. Discuss the procedure for evacuating Fishers Island by ferry.

11.2.3.3 Distribute the Information to Residents Beyond the 10 mile EPZ of Either Plant

Currently, the booklet is only directly distributed to residents within the ten-mile EPZ, in compliance with regulations. There are families who live outside of the ten-mile EPZ, but whose children attend school within the ten-mile EPZ that are not currently mailed the emergency booklet. While the booklet is not be the best vehicle for wider public education, even people outside of the ten-mile EPZ can be affected by the plants, and can by their actions affect the health and safety of those within the ten-mile EPZ. Thus they too should be educated on appropriate emergency responses.

11.2.3.4 Expand the Approaches to Providing Public Information

Some of the counties have had the foresight to make public information available in a variety forms. As mentioned several counties have supplemented the distribution of paper emergency booklets with Internet sites and links on radiological preparedness. For example, each of the county's emergency planning guides is published and available on the Westchester website. Additionally the Putnam, Orange and Rockland sites have links to their guides. Rockland has added an interactive and dynamic map, which allows residents to identify their ERPA and evacuation route. Putnam has placed the evacuation route in the county phonebook and Rockland has placed emergency plan information in school calendars.

These efforts are laudable advancements as they increase the availability and accessibility of information. All the counties should be encouraged to look for ways to distribute this information in a variety of forms. Providing emergency procedures and evacuation maps on the back of sun shades, on car visor inserts, on local calendars and phone books, and in new home purchase packets will improve the accessibility of emergency information, as will having an edition in a size suitable for a car's glove box. Additionally, displaying and distributing this information in community places, such as recreation centers, city hall, banks, senior citizen centers or other locations where the community frequently congregates promotes habitual exposure and increases the likelihood it is available when needed.

11.2.4 Develop and Vigorously Implement a Nuclear Emergency Response Force and Training Program

The public organizations in charge of planning and response at both Millstone and Indian Point do not have a cohesive program to identify critical response positions and train and certify individuals in these positions. The nuclear facilities are required by regulations from the Nuclear Regulatory Commission to identify the Emergency Response Organizations, maintain logs of the training provided to individuals serving in these positions, test and re-test to verify that they have the requisite knowledge and skills, and then to document that sufficient numbers of these personnel are involved in drills and exercises. Unlike the nuclear plant, there is no similar structure for performance management on the off-site side.

11.2.4.1 Develop and Maintain Training and Certification Program

The state, counties and cities should identify the personnel that would fill these positions in case of an incident at Millstone or Indian Point. These individuals should receive training to fulfill their roles. There should be rigorous tests to validate that individuals have the required knowledge and skills to perform their positions. The training should be refreshed at a regular interval and testing should ensure that performance is being maintained.

The state should work with FEMA to develop requirements on what percentage of the response force must be involved in drills and exercises to prove competency in performance of their roles.

Finally, the Emergency Response Organization must also include those who would make protective action decisions and be involved in communicating with the public through the media. Elected and appointed officials would need to interact and speak with one voice during a response. They should be provided briefings on nuclear radiation issues, focused on their leadership roles during response. These leaders should also regularly participate in scheduled exercises.

11.2.5 Implement a Performance Outcome-Based Exercise Program

We previously stated that even though based in good doctrine, plans that are traditionally developed (functional, responsibility-based, and lacking articulation of protection strategy) are problematic. An exercise process that is functionally based, compliance oriented, and specifically lacking in outcomes will be equally problematic and therefore in need of review

The Indian Point and Millstone exercise programs are based on compliance with regulations. For the counties and the State, it requires one exercise every two years. However, the exercise program does not measure outcomes: Did we warn in time? Did we protect people? How many people were at risk in the scenario?

In case of an event at either nuclear plant, the outcomes are what will matter: How many people were at risk and how many were we able to protect? The public will not want to know if the notification was sent within 15 minutes and that the sirens were sounded within 15 minutes after a decision to evacuate or shelter was made. The radiological emergency preparedness exercise program for both facilities should be completely overhauled and changed to a performance outcome focus.

As noted previously, both Indian Point and Millstone lie in densely populated areas. An emergency exercise program for these regions needs to be more rigorous, more focused on achieving outcomes, and more comprehensive. Two years between exercises does not provide enough opportunities for learning, feedback and improvements. We recommend below a comprehensive schedule of quarterly drills and annual exercises.

11.2.5.1 Develop and Implement a Rigorous Performance Outcome Based Exercise Program for both Millstone and Indian Point

We recommend that the State of New York negotiate with FEMA in developing and implementing a performance outcome-based exercise program for both regions. The performance outcomes used in this program should be based on the community-wide process of defining performance outcomes discussed under Section 11.2.1 above.

A performance outcome-based exercise program is currently rare at States, counties and cities, in part because outcome-based exercising is much harder to do. But, waiting to learn from a disaster when it strikes is much more expensive since the “cost” may be translated into terms of people’s lives and health. The specific risk posture of the Indian Point site and the need for sharp improvements in the capacity to protect people require that a performance outcome-based structure be put in place in this region. Although the risk posture in terms of the number of people in proximity to the plant may be more tenable for Fishers and Plum Islands, the benefits of a performance outcome based exercise program are no less desirable for those populations.

Without an exercise program that shows current capability clearly and tracks areas of recommended improvements, other actions may not be effective. In emergency management, exercises are one of the only means (short of real events) that show the effectiveness of the emergency response system and the areas that it needs to improve.

11.2.5.2 Annual Certification Process Should Provide Validation of the Effectiveness of Emergency Management

The State of New York certifies annually to FEMA that the Indian Point region is adequately protected in case of a nuclear event. We recommend that this annual certification be tied to a performance exercise at the site. Emergency response performance should be measured by exercises, allowing the State to make objective judgments on the effectiveness of emergency response systems at the site.

The performance outcomes achieved in each annual exercise should be reported back to the citizens and to other elected officials. Over time this would serve to raise confidence in emergency response capabilities. Citizens understand that improvements take time. Openness and transparency in reporting exercise results helps build public confidence.

Cities, special facilities, private employers, and selected citizen groups or neighborhoods should be encouraged to participate in exercises. Elected officials should participate in exercises to make sure that the decision-making element is well represented and that they receive needed training. We further recommend that interested stakeholders be allowed to observe these exercises.

Aside from the annual certification exercise, the Emergency Response Organization should perform drills every quarter. We recognize that this is a problematic and somewhat costly recommendation that will impact a wide circle of participants. Other agencies not principally responsible for emergency management play important roles in response. In addition, there are emergency responders who are volunteers. However, without drills that provide a chance to test training and improve learning, there cannot be a substantial increase in response knowledge and skills. Drills should be organized for off-duty hours as well as regular work hours, and they should also be organized to test specific activities and therefore restrict the number of people that need to be involved in each one. Nevertheless, there would still be a need for a broad-based regular program, for without frequent drills, skills and learning are lost.

11.2.5.3 Incorporate Lessons Learned into Planning, Training, Exercises and Public Education

Exercises should include a strong "lessons learned" component. Any weaknesses found in exercises should be traced back to changes needed in plans, training, policies, equipment, public education, or job responsibilities. For this learning to occur, exercise reports should be completed within days and weeks, not months. Actions to improve the system should be tracked and re-exercised to make sure that problems have been resolved.

11.2.6 Upgrade Communications Capability

Communications is the life-blood of disaster management. It links emergency response personnel from one community with the response personnel from another community. It also allows integration of data from various sources in the field to provide a composite situation assessment. This situation assessment is then very important in making further decisions on how to intervene in the crisis. Communication systems are also of great importance in making sure that emergency response personnel are safe as they perform emergency actions.

The communication system in the Indian Point region relies largely on regular commercial telephone lines among the various emergency operations centers. The radios available to emergency responders, as at many jurisdictions across the country, are known to have interoperability problems. There are areas in the community where these radios do not work. This issue may be less pronounced for Fishers Island and Plum Island based on the number of jurisdictions and responders coordinating and the flat nature of the terrain. It is a valid preparedness improvement objective nonetheless.

The exercise program has not rigorously tested the communication systems, and the scope of this study did not allow a rigorous test of the communication system either. Our recommendations are based on the sparse data noted in the exercises on communications interoperability and coverage problems, the information we gathered on the characteristics of the communication system in place, and case studies of problems found in similar communication systems in other communities during emergencies.

We offer two recommendations. The first and most important need is for field personnel to have reliable and interoperable communications with each other and their emergency operations centers. The second need is for the emergency operations centers to communicate with each other and with other response facilities. These two aspects are covered in more detail below.

11.2.6.1 Communications for Field Personnel Needs to be Robust and Interoperable

In any event at Millstone or Indian Point, hundreds and perhaps thousands of emergency response personnel would be involved. They need to be able to communicate with each other and with the emergency operations centers.

Recently, the four Indian Point radiological emergency preparedness counties in the region have agreed to partner in the development of wireless communications in the region—a good start. The region needs a cohesive, interoperable and robust communication structure to allow all emergency response personnel to communicate quickly, continuously, and effectively. We recommend that a wireless communication system be put in place quickly.

11.2.6.2 Communication Capability Should be Better Utilized Among Emergency Operations Centers and Other Response Facilities

Emergency operations centers in the region have dedicated and secure links with each other. During the practice and full scale exercises at Indian Point, backup systems to include radio were observed to be operational for EOC to EOC communications and for communications between EOC and selected activities in the field. Also, a number of other special facilities expected to be involved in emergency response, including hospitals, schools, reception centers, and the Joint News Center have dial-up and other types of links with Emergency Operations Centers, but backup radio systems were not always available. Examples include the lack of defined backup based on our interviews with Good Samaritan Hospital, observation of a congregate care exercise in early September for Indian Point, and the review of communications in the Fishers Island emergency plan as related to the Millstone evaluation.

The State and the counties should stress these links by coordinating more sharing of information over these links during exercises. Conducting exercises using the local phone system is appropriate in most cases. But that system can be expected to be overwhelmed in a major disaster. Some exercises and drills should involve rigorous tests of the capability to communicate and coordinate using backup systems.

11.2.7 Upgrade Level of Response Management Technologies

The Indian Point region is using old, out-dated technologies in a number of areas. The hazard assessment process uses 25 to 30 year old map overlays for determining the area at risk. The hazard information specific to the dose assessment is communicated via phone or fax to the State and counties. Plume information is currently not available through operable automation systems that can show the State and counties the precise areas that are at risk. Hazard assessments do not integrate with population data and do not show the time that various zones would be at risk. Millstone has more modern computer tools to complete the dose assessment, but the system still suffers from many of the same shortfalls as Indian Point in terms of translation, communication and interpretation of hazard information.

In providing warning to the people, there is an over-reliance on sirens and the Emergency Alert System. Newer technologies, such as tone alert radios, should be comprehensively considered.

When making protective action decisions, officials must consider what has happened, how it could affect people, the time windows available for actions, action alternatives, and the resources and constraints attendant on each action alternative. Currently, the protective action decision making process is very simplistic, and there is virtually no technology support for these decisions. We recommend that technology supports for protective action decision-making during response be significantly upgraded.

Technology is not a panacea for risks at Indian Point or Millstone. However, many technological advances allow better and faster means of protecting people. These technologies are useful not just for protection against incidents at either nuclear plant, but are effective against many different types of emergencies. Federal funding for upgrades to emergency response systems is expected to be made available to States, counties, and cities. Both the Indian Point and Millstone jurisdictions should upgrade significant portions of their planning, training and response management technologies.

11.2.7.1 Upgrade Hazard Assessment Technology

We recommend that the Indian Point hazard assessment technology infrastructure be significantly upgraded. The Indian Point is using 1970s-vintage overlay information to calculate the area at risk. These overlays are not capable of taking into account wind shifts and complex weather patterns. The information from this hazard assessment is communicated via telephone lines using paper forms. Plume data is not being sent electronically from the facility to the State and counties.

We recommend that the Indian Point facility, State of New York, counties, and cities install a more sophisticated nuclear atmospheric dispersion model. This model should be calibrated to incorporate meteorological information from the local area as well as the results of radiation detection and measurement devices, fix-mounted to provide real-time measurements of radiation status. This model should also be validated against the tracer experiments conducted in the Hudson River Valley. The model must provide information on the time of exposure of the population.

We recommend that the Millstone plant and surrounding radiological emergency preparedness jurisdictions link their automated hazard assessment capability so that information does not need to be extracted from the computer and transmitted via other communications systems. The State of New York should further validate MIDAS results with data specific to Millstone's land-sea interface and surrounding terrain. MIDAS should be upgraded to provide information on the time of exposure of the population.

Both the Indian Point and Millstone hazard models should be linked to the emergency operations centers at the State and counties. The facility needs to be able to send plume data quickly and accurately to the State and counties, and to principal jurisdictions. This communication should be via a dedicated circuit, so that communication congestion during response does not affect the ability to share this vital information. This point is particularly relevant for Millstone. The State of New York should not be dependent on the State of Connecticut's or anyone else's interpretation of a radiological hazard threatening Fishers or Plum Island. The State of New York should have access to the dose assessment, plume plots and hazard time information in real time during an event at Millstone. They should also include Millstone in their REP plans, considering the possible need for federal support, state resources like the National Guard, and local public safety issues.

The State, counties, and cities must have technology, procedures, and trained personnel to receive and understand this information. They must have updated population data to interface with the hazard assessment, indicating who would be at risk and when. All these technologies are commercially available and should be integrated into the region's emergency response system as soon as practicable. Having a picture of who is at risk and when others will become at risk can make a substantial difference during response.

11.2.7.2 Upgrade Protective Action Decision Support Technology

Currently, the counties plan to evacuate areas at risk for most radiological emergencies. If there is not sufficient time, the counties plan to shelter. However, these planned actions have not been examined in a comprehensive manner to determine if they are feasible and whether they would or would not expose people to higher levels of radiation.

In Section 11.2.1 above we recommended that the State, counties, and cities develop a set of protective action strategies based on modeling. These model results can be folded into a decision heuristic that can be applied without the use of computers. Or, conversely, the model results can be archived in a database and retrieved via computer during response. We recommend that the Indian Point and Millstone off-site emergency organizations pursue both paths. Computer databases with the strategies for protecting people should be developed and available as decision support systems for response. In addition, there should be a non-computer based system to arrive at the best protective action decisions for a variety of contingencies. The non-computerized system would be required as a backup in case computer systems were lost during response.

11.2.7.3 Upgrade Operations Management Technology

Finally, there are many areas in response management where technology insertion would be beneficial. We mentioned a number of these—fixed monitoring for radiation; use of reverse telephone calling systems to speed notification to selected populations or businesses; integration of the alert and notification with larger business information technology systems to spread the warning to employees fast; adding integrated Geographic Positioning System capability where it does not currently exist for police, fire services, emergency medical services and response transportation assets. We also recommend that the State of New York conduct a study to determine additional areas where technologies are available to assist in response management.

Radiation is an invisible hazard: it is important to know where exposure can occur. Therefore, we recommend taking a close look at the issue and determining if a different concept of radiation monitoring might be more effective. It is possible to fix-mount radiation monitors at locations throughout the community and measure radiation and automatically transmit the results real-time from these stationary devices. A number of studies are being conducted by several federal agencies on the optimal arrangement of monitoring and detection devices for various nuclear, biological, and chemical agents. The Indian Point region should examine how monitoring can best be performed. Considering alternatives such as fixed monitors frees human resources for other emergency needs. We expect Millstone would benefit from the same understanding.

11.2.8 Summary

GENERAL: The Nuclear Regulatory Commission (NRC) has stated as recently as Nov 18, 2002, that a preliminary assessment by the Federal Emergency Management Agency (FEMA), based on the September 24, 2002 exercise, indicates the off-site emergency plans are adequate to protect public health and safety. While under the current regulations that may be technically true, we are concerned that when plans and exercises that omit such things as realistic consideration of spontaneous evacuation and the unique consequences of a terrorist attack still meet NRC and FEMA regulations, then those regulations need to be revised and updated. We believe a plant adjacent to high population areas should have different requirements than plants otherwise situated, because protective actions are more difficult and the consequences of failure or delay are higher. The standard, to minimize the radiological dose to the public for a spectrum of accidents, would remain the same; its accomplishment necessitates higher requirements in some communities than others.

In addition, we find a pressing need to take advantage of new technologies for the protection of the people. Also, plans and exercises should be directly based upon the achievement of the current standard for doses to the public. Our recommendations are designed to assist the State and its jurisdictions in meeting the higher requirements we believe need to be developed.

INDIAN POINT: In our report we discuss significant planning inadequacies, parental behavior that would compromise school evacuation, difficulties in communications, outdated vulnerability assessment, use of outdated technologies, lack of first responder confidence in the plan, problems caused by spontaneous evacuation, the nature of the road system, the thin public education effort, and the impact of these on effective response in high population areas. None of these problems, when considered in isolation, precludes effective response. When considered together, however, it is our conclusion that the current radiological response system and capabilities are not adequate to overcome their combined weight and protect the people from an unacceptable dose of radiation in the event of a release from Indian Point, especially if the release is faster or larger than the typical REP exercise scenario (often called "design basis release"). Should our recommendations be successfully implemented it is possible that an improved exercise program will demonstrate that a different conclusion is warranted in the case of a design basis release.

MILLSTONE: Although most of the problems mentioned above also apply to those New York jurisdictions near Millstone, their consequences are significantly less for reasons detailed in the report. The response system and capabilities of those jurisdictions, though inferior to those near Indian Point, should be able to protect New York citizens from an unacceptable dose of radiation in all but the most extreme event. Implementation of our recommendations should dramatically increase that margin of safety.

11.3 Two Additional Points

Even though numerous flaws were found in the emergency management system, and we recommend a number of improvements, a true test of a system is when it faces an emergency. People and organizations often rise to the challenge and reach beyond their capabilities. How the Indian Point or Millstone emergency management systems would function in an actual emergency is unknown.

However, there are case studies that show that planning and preparedness for these types of emergencies has been useful in past events. Emergency professionals generally agree that communities that have undergone nuclear planning are more rigorously prepared and capable than most communities that do not have nuclear power plants in their midst. For instance, in Taft, Louisiana, a chemical plant explosion occurred in the middle of the night in the early 1980s.[177] Plans and procedures in place for the nearby nuclear power plant were used to successfully warn and evacuate 17,000 people in the night.

Another intriguing example involves an exercise-related study at the Robert E. Ginna nuclear power plant in 1983.[178] The exercise and study focused on the degree of stress suffered by emergency personnel and the nature and volume of information being communicated. Two weeks later, a real event occurred which closely mimicked the exercise scenario. The authors of the initial study returned to review the stress and information exchange associated with the real event and compare it to the exercise data. The close correlation between the exercise data and the real event indicates that nuclear power plant exercises may still be a reasonably accurate judge of the stresses placed on emergency response personnel.

The second important point is that some may look at our findings, conclusions and recommendations and read them, incorrectly, as an indictment of FEMA or the State and its jurisdictions, and their staff and leadership. FEMA has recognized the need to change in the direction of a more performance based approach in its exercise program. Although the change does not go far enough, it began with a multiyear strategic review of the REP program, and resulted in a new exercise methodology developed prior to 9/11 and published in the Federal Register on September 12, 2001. This beginning of a change in exercise theory to focus on performance outcomes is not yet found in the planning and exercising practices of the State of New York and its jurisdictions however. We hope our recommendations will accelerate this cultural change.

Also, while we do have many recommendations for further change that impact on FEMA systems and practices, we recognize that these systems and practices were developed in a different environment. Simply stated, the world has recently changed. What was once considered sufficient may now be in need of further revision. We are hopeful and expect that those at all levels of government with emergency management responsibilities will consider our suggestions in a manner that is consistent with their high standards and professional experience.

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[177] Quarantelli, E.L., Brenda D. Phillips, and David C. Hutchinson. *Evacuation Behavior: Case Study of the Taft, Louisiana Chemical Tank Explosion Incident*. 1983.
[178] Belardo, Pazer, Wallace, and Danko, "Simulation of a Crisis Management Information Network: A Serendipitous Evaluation." 1983.

11.4 Limitations and Omissions

There are certain areas in which data and observations were limited, or in some cases information was not available on which to make preparedness judgments during this review. A front-to-end review of every facet of the emergency preparedness program for Millstone, Indian Point, the State of New York, the emergency planning zone counties, and specific populated areas such as Fishers Island or individual municipalities in the emergency planning zone would be insurmountable. This is due to the dynamic nature of the preparedness system itself and to limits in time and resources to get such a large-scale analysis done. Such resource and time limitations are faced by the State and Counties, supporting facilities and others that are providing information on which the study is based, on the study contractor's scope, and on time available to execute that scope.

The James Lee Witt Associates and IEM team can state that sufficient elements of the preparedness system were analyzed to provide a comprehensive basis on which to defend the conclusions and recommendations stated in this report. Some of these conclusions and recommendations could be further characterized or prioritized by the State of New York through the introduction of additional information. It is the opinion of James Lee Witt Associates and IEM that additional information would not fundamentally eliminate or change the conclusions and recommendations. The limitations and omissions are stated here for completeness and additional context.

The James Lee Witt Associates/IEM team was not tasked to study the physical security of the Indian Point or Millstone plants, or the credibility of terrorist attacks or other potential initiators of a radiological event at either facility.

Advocacy groups have proposed the use of a 17.5 mile "peak deaths zone" as the basis of emergency planning for the public. This proposal is based on information in a 1982 Sandia National Laboratory (SNL) Report, "Calculation of Reactor Accident Consequences" also referred to as the "CRAC-2" report. The NRC was recently petitioned to support an assertion that this report provided an accurate planning basis for a radiological accident, specifically that a terrorist attack could initiate a release causing fatalities at distances beyond the ten-mile emergency planning zone.[179] The NRC replied that "The reactor citing studies in the CRAC-2 Report were performed as part of research on the sensitivity of various plant siting parameters. The studies used generic postulated releases of radioactivity from a spectrum of severe (core melt) accidents, independent of the probabilities of the event occurring or the impact of mitigation mechanisms. The studies were never intended to be realistic assessments of accident consequences. The estimated deaths and injuries resulted from assuming the most adverse condition for each parameter in the analytical code. In the cited studies, the number of resulting deaths and injuries also reflected the assumption that no protective actions were taken for the first 24 hours. The studies did not, and were never intended to, reflect reality or serve as a basis for emergency planning … the SNL studies provided a useful measure to compare sites, not to analyze plant-specific accident consequences." Use of the CRAC-2 analysis in the JLWA study would represent a misuse of scientific data and contribute to the misinformation now hindering the public discussion of the issues involving the plants.

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[179] DD-02-06. USA Nuclear Regulatory Commission Office of Nuclear Reactor Regulation. Director's Decision Under 10CFR 2.206 In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Unit Nos. 1, 2 and 3.)

Any action taken in an emergency has uncertainty associated with it. Likewise observations of emergency actions in exercises or as defined in interviews can have uncertainty associated with them. Organizations and people have the ability to adapt during a response, so actions can vary emergency to emergency. Many preparedness shortfalls can be addressed in a response using emergent processes or adaptation, whereas systemic issues can be much more problematic. We have focused on the systemic, while acknowledging that many things can be “handled” if an emergency were actually to occur.

There are specific omissions that we have determined did not significantly hinder our review. In general, these omissions are plan annexes or appendices, administrative procedures, equipment inventories, and other attachments to plans or concept of operation documents. Access to such information varied from plant to plant, county to county, and at the two states. A comprehensive list of omissions is not reproduced here, but most are detailed in the individual plan review compliance matrices extracted in the individual plan review appendix. For example, in each plan review compliance matrix in Appendix C, the reader will see a number of observations where the plan technically did not contain an item required in a NUREG or Environmental Protection Agency document and the reviewer inferred or was told that it was covered in a particular plan annex or operating procedure. However, the reviewer did not have access to the specific annex or procedure, and therefore could not verify that the item was in fact there. The state may wish to review the compliance matrices to determine if there are concerns over particular items.

There were some variations in the amount of planning basis information available for Millstone and Indian Point to support the population analysis, the evacuation time estimate evaluation, the alert and notification evaluation and the assessment of communications systems. There were specific limitations to the quantity and type of data available from KLD as related to their ongoing evacuation time estimate update for Indian Point (the evacuation time estimates will be published after our report is delivered to the State of New York). Specific limitations or omissions for each of the planning basis areas are detailed in the summaries of the analyses presented in Chapter 5 of this report. If an omission is significant enough to impact the ability to reach a preparedness conclusion, the accompanying written summary will so state. There are only a small number of isolated areas in which this was the case.

The data collected during Indian Point practice and full-scale exercises (September 5 and 24, 2002 respectively) were limited primarily to the Indian Point Emergency Operations Facility, county Emergency Operations Centers, the State Emergency Operations Center, and the Joint News Center. We were not able to personally observe a number of operational field activities such as conduct of field monitoring by county responders. Therefore we attempted to gain additional insight on field activities by coordinating with the Emergency Operations Centers as the exercise progressed. Additionally, some gaps in information were filled via interviews with emergency managers, support facilities, and emergency services personnel during or subsequent to the exercise.

IEM did not focus on collecting a large number of specific observations on the relative advantages or inadequacies of EOCs from the "brick and mortar" or operational layout perspective. There are some observations as to communications connectivity or interoperability issues as result from operations in EOCs, but our focus was on the response processes and outcomes versus the space in which they were realized. Our collective professional experience has been that organizations can make space and people work out in an adaptive sense during an emergency, and workarounds will be found for the equipment or communications failures. But, organizations won't as easily overcome lacking or absent strategies. Our focus was clearly on evaluating the strategies, and trying to identify where they were not present. In addition, there was a limited window to observe EOC operations. The full capabilities of an EOC are difficult to evaluate unless there are specific objectives to stress it and the organization that operates in it, and one day of REP exercise format is simply not enough to accomplish this. As a result, we focused our evaluation on "how the organization protected people in an emergency" versus "how the organization was housed to respond." That priority of effort was in our judgment closer to the fundamental questions being asked by the State of New York.

During our review we were frequently asked whether we were under constraints. The general answer is that we were guided by our experience and were unconstrained in our recommendations.

A more complete answer would include the following:

- In his press conference of August 1st, 2002 -, Gov. Pataki clearly articulated that “nothing was off the table,” and that he wanted an independent review. In our interactions with the public we were asked if this meant we were free to recommend closure of the plant. We are free to make recommendations regardless of their implications for the future of the plant.
- Recovery after an incident, reentry into the affected areas, the availability of alternate energy sources, Emergency Operations Center (EOC) redesign, economic damages incidental to a release and/or consequent protective actions, and plant security are significant issues that lay outside of the scope of our review.
- The current distribution of Potassium Iodide (KI) is also beyond the scope of the contract, but in this case a good deal of information was obtained in the course of our other efforts. Although we have not performed a comprehensive review of the issues involved in its distribution we have, where appropriate, included our observations based on the information obtained.
- Evacuation Time Estimates (ETEs) posed a vexing problem. In order to best evaluate the safety of the public under several evacuation scenarios we needed accurate evacuation estimates. All seem agreed that current estimates are out of date and some of their assumptions are questionable (e.g., they did not consider shadow evacuation). Entergy Nuclear Northeast has contracted with KLD Associates, Inc. for the updating of the ETEs but the results of that effort will not be available until after the final report on our effort is due. Nevertheless we were able to review KLD’s assumptions and methodologies as discussed in section 5.2, and are confident their product will be a vast improvement.
- We were constrained by the widely varying cooperation of the counties we needed to work with.
- The level of public education, as opposed to awareness, limited the amount of productive interaction we could have with the public. Our expectations regarding ideas we might get from our outreach effort were dashed by widespread apocalyptic attitudes. The information provided by advocacy groups is readily available, professionally produced, and targeted to appeal to the emotions. Information provided by the State, Counties and the plant(s), is ineffective in comparison. It is ineffectively distributed and targeted to minds receptive to instructions from the government.

The above statements are meant to be explanatory of some of the difficulties faced, and limitations inherent in the course of our review. They are not to be read as excuses for our conclusions and recommendations. If we did not have reasonable confidence in our conclusions and recommendations, they would not be included in this report.

CONTRIBUTORS

James Lee Witt Associates (JLWA) completed a comprehensive and independent review of emergency preparedness for the area adjacent to the Indian Point and for that portion of New York in proximity to the Millstone plant in Connecticut. JLWA contracted with Innovative Emergency Management (IEM) to perform portions of the technical review and analysis found in the draft report. Their capabilities and professionalism are impressive, and their contributions both important and indispensable. Nevertheless, JLWA remains responsible for the contents and recommendations found in the Report.

James Lee Witt Associates, LLC

James Lee Witt has been at the forefront of disaster and crisis management for over 25 years. As Director of the Federal Emergency Management Agency from 1993-2001, Witt was responsible for the agency's overhaul. His leadership abilities have been praised by numerous nationally recognized organizations, including the Council for Excellence in Government, Harvard University's Kennedy School of Government, and the National Association of Broadcasters. Witt led FEMA through more than 348 Presidential declared disasters in more than 6,500 counties in all 50 states and territories, including the most costly flood disaster in the nation's history, the most costly earthquake, and a dozen damaging hurricanes.

James Lee Witt has more than 25 years of experience in disaster and crisis management. He served as Director of FEMA from 1993-2001 and was the first FEMA Director to be elevated to the President's cabinet. Under his leadership, Witt transformed FEMA into an effective customer oriented, disaster preparedness and response agency that provides hands-on assistance to those at risk, both before and after disaster strikes. FEMA is the federal agency responsible for evaluating and exercising the emergency response plans for the Radiological Emergency Preparedness program, which is responsible for the 103 commercial nuclear reactors across the country.

Prior to his FEMA appointment, Witt served as Director of the Arkansas Office of Emergency Services and coordinated for the nuclear preparedness, response and evacuation capability for Arkansas 1 and 2 nuclear reactors. He also served as chairperson of the Arkansas State Nuclear Advisory Board while serving as County Judge, the chief elected official of Yell County.

A native of Arkansas, Witt's professional career began with the formation of Witt Construction, a commercial and residential building company. After 12 years as a successful businessman and community leader, he was elected County Judge for Yell County, serving as the chief elected official for the county, with judicial responsibilities for county and juvenile court. At age 34, he was the youngest elected official in Arkansas, and was later honored for his accomplishments by the National Association of Counties. After being re-elected six times to the position, Witt was tapped by then-Governor Bill Clinton to assume leadership of the Arkansas Office of Emergency Services.

Currently, as President of James Lee Witt Associates, LLC, Witt provides local governments, the international community, corporations, hospitals, universities, and other non-profit organizations with innovative disaster mitigation solutions, including planning and preparation. The firm also offers a complete range of recovery services in the event of natural and manmade disasters. Other services include distinctive marketing and strategic advice. Mr. Witt has just completed his first book; *Stronger in the Broken Places* is based on his first-hand experience dealing with disasters and how his common-sense approach to government can be applied to the everyday citizen.

Ray Williams has 28 years of professional emergency management experience. He is now an independent contractor, and became Project Manager for this JLWA effort in July of 2002.

Before joining JLWA , he served as Deputy Regional Director for FEMA Region 10, in Seattle, Washington. As Deputy to the politically appointed Regional Director, he had oversight of preparedness planning and operations, of coordination with State and local governments, and of federal disaster response and recovery in the Pacific Northwest and Alaska. Included in the work of the Region was offsite planning and exercising for commercial nuclear power plants, for nuclear weapons accidents, and for a facility being built to destroy chemical weapons.

The Director of FEMA appointed Ray Williams to be the Deputy Director of an Interagency Emergency Management Team for the West Coast, which assignment began at the start of the Reagan administration and continued until the demise of the Soviet Union. The Team was comprised of a large number of representatives from many federal agencies. Most of the purposes, and operations of the Team were classified, as were all of the many lengthy exercises. The concept of operations was similar to the Federal Response Plan.

Mr. Williams' experience at FEMA and in the emergency management field included direct and second level supervision of medium sized organizations. These organizations were comprised of many professional specialists such as civil engineers, emergency planners, disaster responders, communications and information specialists, exercise planners, a community outreach team, and security personnel.

For a cumulative total of 4 years he also served as Acting Regional Director of FEMA Region 10. Because of his experience, the Director of FEMA asked him to serve as Acting Regional Director in the San Francisco Region (Region 9), an assignment that lasted approximately 12 months, ending when the White House appointed a new Director. The San Francisco Region was geographically dispersed, had a powerful delegation in the Congress and an active union, was housed in historic buildings and, during his service, engaged in several major disaster response and recovery operations.

For years he was a volunteer fire fighter, an activity that directly contributed to his understanding of emergencies at the grass roots level. He was also active on and served as president of the local school board for a large school district, considerably enhancing his executive and leadership skills. He received an MA in Political Science from the University of Chicago, where he also did additional graduate work.

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Madhu Beriwal, M.U.P., is a Senior Emergency Manager and the President and CEO of IEM, Inc. Ms. Beriwal is a recognized expert in emergency response planning, especially as related to events involving weapons of mass destruction. She has more than 17 years of experience managing high-technology research activities. Ms. Beriwal served by special invitation as Moderator for the Defense Threat Reduction Agency's Chemical and Biological Modeling and Simulation Futures Panel. She was also a member of the Defense Science Board for Intelligence on Terrorism. She has experience in traffic modeling, transportation plan design, evacuation plan development, and the design and use of evacuation planning tools in emergency management. She has authored or co-authored a large number of articles and technical studies on emergency planning and response issues and has delivered several conference presentations on the same issues as an invited speaker. Ms. Beriwal holds a Master's Degree in Urban Planning from the University of Kansas and a Bachelor's Degree in Geography.

Robert Berry, M.A., is an Emergency Manager with extensive experience directing emergency preparedness and disaster management activities, coordinating preparedness efforts with Federal, State, and local agencies, and coordinating security for military munitions movement. Mr. Berry has experience in risk assessment and hazard analysis; emergency management analysis; development of emergency management plans, procedures, and guidelines; exercise design and evaluation; and implementation of activities in emergency planning, community right-to-know, and the Environmental Protection Agency's (EPA's) Risk Management Program. Mr. Berry has served as the North Atlantic Treaty Organization's (NATO's) disaster evaluation director in Turkey, where his development, implementation, and maintenance of disaster planning and emergency management evaluations, guidelines, and training courses helped ensure that NATO forces were prepared to survive and continue operating during wartime conditions, including nuclear, biological, and chemical (NBC) warfare. Mr. Berry holds a Master's Degree in Public Administration.

Brian Boyle, M.S., P.E., is Manager of IEM's Test and Evaluation Product Group and has over 12 years of experience in risk analysis and emergency management. Mr. Boyle has carried out systems analyses, including business process reengineering, for three military installations that store chemical weapons. Mr. Boyle possesses expertise in the areas of dispersion modeling, hazard analysis, software testing, and quality assurance. He played a leading role in developing threat scenarios and hazard modeling for IEM's study of the impact of an asymmetric chemical/biological (CB) attack on the Force Projection mission of a key military installation. Mr. Boyle holds both a B.S. and an M.S. in Nuclear Engineering from UC Berkeley and the University of Illinois respectively, and is a registered professional engineer in that discipline. He did engineering work with four nuclear plants at three sites while employed by Entergy at the corporate level and was stationed for over four years on the nuclear engineering staff of River Bend Station. Initially Mr. Boyle served as the plant operations analyst. In October 2002, prior to preparation of the draft report and at the request of James Lee Witt Associates Mr. Boyle was removed from the project. This was deemed necessary in light of his prior Entergy experience.

Rex Coble is a Senior Emergency Manager with more than 28 years of emergency management planning and response experience in a variety of disciplines, including law enforcement, fire, emergency medical service, and public health. He served for seven years as the Deputy Director and Interim Acting Director of the Illinois Emergency Management Agency (EMA), which is responsible for managing disasters in Chicago. Mr. Coble has managed eight presidential-declared disasters, nine gubernatorial-declared disasters, and countless other emergencies in the State of Illinois. Mr. Coble was also the Governor of Illinois's designated point of contact and Terrorism Coordinator for all State agencies under the Governor's control. Mr. Coble holds a degree in Management.

Christian Fosmire, M.S., is an Atmospheric Scientist. Mr. Fosmire's background is in boundary layer meteorology and chaos theory, specializing in atmospheric time series analysis. Mr. Fosmire has worked primarily on computer programming, data collection, and analysis in the area of atmospheric diffusion modeling and risk assessment. He is involved with IEM's D2-Puff™ model, and has also been involved in the testing of D2-Puff as well as IEM's meteorological data processing program. Mr. Fosmire has participated in four large field exercises since 1995. These annual field exercise evaluations for the Hanford Site, a Department of Energy Site in Washington State, involved radiological release scenarios. He participated as a meteorologist during the exercise along with the emergency management agencies, Benton and Franklin Counties, Washington and Oregon States, and the Department of Energy. He has also participated as a meteorologist in 12 limited field exercises that involved the Hanford Site Emergency Operations Center and occasionally Benton County or Washington State. Mr. Fosmire holds a Master's Degree in Meteorology from Pennsylvania State University. He has authored or co-authored ten scientifically peer reviewed journal articles and has presented a similar number of technical presentations at international conferences or symposia.

Joseph Kammerman, M.S., is a Transportation Analyst with experience in travel demand forecasting, data analysis, and corridor analysis. Mr. Kammerman also has considerable knowledge in geographic information systems, evacuation planning, and emergency planning. He also has trained and received numerous certifications in the areas of terrorism response, disaster recovery, risk and vulnerability management, and disaster assistance. Mr. Kammerman holds a Master's Degree in Emergency Management from George Washington University and a Bachelor's Degree in Urban and Regional Development.

Theodore Lemcke, M.S., is IEM's Vice President for Core Technologies. He has more than 22 years of military and professional experience in environmental risk quantification, risk management, risk communication, modeling and simulation of WMD threats, and emergency management program analysis and design. By integrating behavioral sociology with simulation modeling, Mr. Lemcke played a key role in developing IEM's core technology, Quantitative

Emergency Management (QEM®). QEM, the most sophisticated process yet developed for analyzing emergency response, has been applied at all U.S. chemical stockpile sites and several privately-owned chemical companies. Mr. Lemcke has managed numerous large-scale IEM efforts in the U.S. and internationally involving emergency management preparedness and response strategies, readiness assessment, domestic terrorism, military operational capabilities, modeling and simulation, risk management, and public outreach. Mr. Lemcke is a graduate of the United States Military Academy, West Point with concentrations in basic sciences, mathematics and engineering and holds a Master's Degree in Environmental Science. He has authored or co-authored a large number of technical studies, operational guides and training materials covering practical emergency response problems, with a large number focusing specifically on measurement of protection for populations exposed to rapid onset hazards. He has done a number of technical and practical presentations as an invited speaker to emergency planner and responder audiences, including internationally.

Jack Long, B.S., a Senior Emergency Manager, has more than 20 years of direct experience in public safety, emergency management, and project management. He specializes in risk and hazard analyses for technological hazards; vulnerability assessments; public information, education, and risk communication programs; and regulatory compliance, licensing, and permitting support. Mr. Long has extensive experience in radiological emergency preparedness and has supported the development of off-site preparedness programs for local governments and special facilities within the emergency planning zones of a number of nuclear plants, including Limerick, Peach Bottom, Seabrook, Enrico Fermi, South Texas Project, and Calvert Cliffs. Mr. Long currently manages IEM's support to FEMA Headquarters in Washington, DC, for the integration of all emergency preparedness activities being conducted by the U.S. Army, FEMA, and State and local emergency management agencies within the Chemical Stockpile Emergency Preparedness Program (CSEPP). Mr. Long holds a degree in Biological Health.

Gary Scronce, M.S., is Manager of IEM's Crisis and Consequence Management Product Group. Mr. Scronce's experience includes nuclear engineering, response and special-facility planning, evacuation time estimate development, exercise evaluation, safety evaluation, and process management. Mr. Scronce is a registered engineer in training (EIT) and holds both a B.S. and an M.S. in nuclear engineering from Kansas State University. He has been formally trained and/or certified in approximately 25 nuclear or emergency preparedness areas. He is a member of the American Nuclear Society, the Louisiana Emergency Preparedness Association, and the Louisiana Nuclear Society. Mr. Scronce worked at River Bend Station for over 12 years as a design engineer, nuclear fuels engineer and fuel fabrication coordinator. He was a member of the plant ERO staff for over seven years. Initially Mr. Scronce served as the IEM Project Lead for the Indian Point Evaluation team. In October 2002, prior to preparation of the draft report and at the request of James Lee Witt Associates Mr. Scronce was removed from the project. This was deemed necessary in light of his prior Entergy experience.

Jessica Soileau is a Risk Assessment Analyst for IEM. Ms. Soileau holds a B.S. degree in biological science. Her previous professional experience includes radiation laboratory analysis and radiation regulation enforcement in the areas of medical and industrial uses of x-ray and radioactive materials. Ms. Soileau holds memberships in several professional organizations, including the Conference of Radiation Control Program Directors (CRCPD), the American

Nuclear Society, the International Association of Women in Nuclear (WIN), the Tennessee Mammographers Association, and Women in Aviation International (WIAI). She was elected Vice-Chair of the Louisiana Nuclear Society for 2002–2003.

Steven Stage, Ph.D., is a Senior Meteorologist and Hazard Analyst at IEM. Dr. Stage specializes in the application of atmospheric dispersion models to emergency planning, risk assessment, and safety analysis. He has developed methods of computing and displaying risks associated with the demilitarization of the chemical weapons stockpile. Specifically, Dr. Stage formulated the theoretical bases for computing the dispersion of chemical agents and, in some cases, carried out the analysis. He has done several studies analyzing risks associated with the chemical stockpile and estimating the impact of proposed actions on public safety. Dr. Stage acted as Task Leader for the development of the IEM's D2-Puff™, a downwind prediction model originally designed to assist emergency planners in the U.S. Army's Chemical Stockpile Emergency Preparedness Program (CSEPP). The model has recently been approved for Army use by the Department of Defense Safety Board (DODESB). He has over 30 years of experience working in meteorology and on transport and diffusion of hazardous materials, to include radiological releases. In addition to his time at IEM, he has served as a university professor and a principle investigator at Pacific Northwest Laboratory and the Hanford DOE site. Dr. Stage holds a Ph.D. and an M.S. in Meteorology from the University of Washington.

Brad Tiffee, M.Ap.Stat., is a Statistician in IEM's Decision Support Product Group. Mr. Tiffee specializes in Quantitative Emergency Management (QEM®), process development, and quality control. Mr. Tiffee has participated in numerous quantitative analyses, including resource allocation analyses, risk assessment, and evacuation time estimate development for the nuclear industry. He has also been a primary participant in IEM protection studies related to the U.S. Army's stockpile of chemical weapons, and has served as an evaluator for several emergency preparedness exercises. He has received certifications in the areas of terrorism response, radiological emergency preparedness and response, and disaster recovery and assistance. Mr. Tiffee holds a Master's Degree in Applied Statistics from Louisiana State University.

Neeraj Mainkar, Ph.D., is a Physicist and Simulation Modeler at IEM. He is also Manager of IEM's Risk Analysis Product Group. Dr. Mainkar specializes in the areas of computational physics and mathematical modeling. He has contributed to theory development in atmospheric dispersion models, design and development of a cellular-automata-based traffic simulation model. He has also studied and analyzed state-of-the-art ray-tracing-based sound propagation models for studies in acoustic coverage. He was involved in the design and development of IEM's Quantitative Emergency Management simulation model. He has been involved in several risk-analysis studies dealing with the Army's chemical stockpile. Dr. Mainkar was task-lead for the enhancement of IEM's D2-Puff™ a downwind chemical hazard prediction model developed for the Chemical Stockpile Emergency Preparedness Program. He has over 10 years of experience and has published papers in both experimental and computational physics, mathematical and simulation modeling. He is a member of the American Physical Society and a member of the Society of Computer Simulation International. Dr. Mainkar holds a Ph.D. and an M. S. in Physics from Louisiana State University.