



### 4.3.12 Nuclear Incident

Nuclear hazards and incidents generally refer to incidents involving (1) a release of significant levels of radioactive materials or (2) exposure of workers or the general public to radiation. Primary concerns following a nuclear incident or accident are the impact on public health from direct exposure to a radioactive plume; inhalation of radioactive materials; ingestion of contaminated food, water, and milk; and long-term exposure to deposited radioactive materials in the environment that may lead to either acute (radiation sickness or death) or chronic (cancer) health effects.

The nuclear industry has adopted pre-determined, site-specific Emergency Action Levels (EAL). The EALs provide the framework and guidance for observing, addressing, and classifying the severity of site-specific incidents and conditions that are communicated to off-site emergency response organizations (Nuclear Regulatory Commission [NRC] 2008). Additional EALs specifically deal with issues of security, such as threats of airborne attack, hostile action within the facility, or attack on the facility. These EALs ensure that appropriate notifications of a security threat will occur in a timely manner.

The NRC encourages the use of Probabilistic Risk Assessments (PRA) to estimate quantitatively the potential risk to public health and safety considering the design, operations, and maintenance practices at nuclear power plants. PRAs typically focus on accidents that can severely damage the core and that may challenge containment. Federal Emergency Management Agency (FEMA), Pennsylvania Emergency Management Agency (PEMA), and county governments have formulated Radiological Emergency Response Plans to prepare for radiological emergencies at the five nuclear power-generating facilities in the Commonwealth of Pennsylvania. These plans include a Plume Exposure Pathway Emergency Planning Zone (EPZ) (an area with a radius of 10 miles from each nuclear power facility), and an Ingestion Exposure Pathway EPZ (an area with a radius of 50 miles from each facility).

#### Location and Extent

There are five nuclear power generation stations located in the Commonwealth; however, none are located within Pike County limits. The County is located within the 50-mile Ingestion Exposure Pathway EPZ of the Susquehanna Nuclear Power Plant located in Luzerne County and Indian Point Power Plant located in Buchanan, New York. Should an accident occur at either facility, the area within the Ingestion Exposure Pathway EPZ could receive some radioactive contamination. The Indian Power Plant is set to close by 2021. Figure 4.3.8-1 provides visual representation of where Pike County falls in the Plume Exposure Pathway EPZ and Ingestion Exposure Pathway EPZ of nuclear power plants.



Figure 4.3.12-1. Pike County Jurisdictions in the 50-Mile Ingestion Exposure Pathway Zone

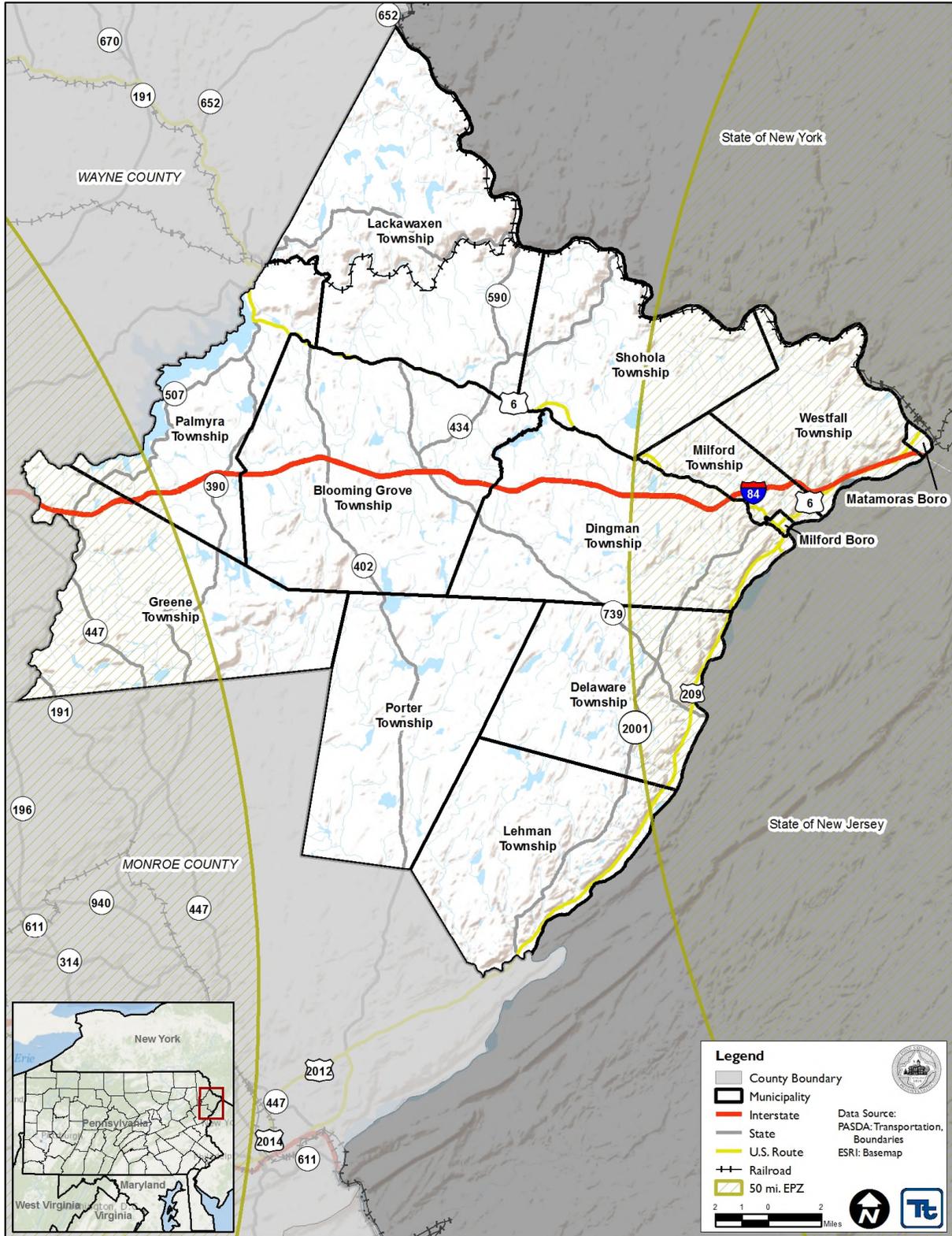




Table 4.3.12-1 lists the jurisdictions in Pike County that are located within the 50-mile EPZs for Susquehanna Steam Electric Station and Indian Point Power Plant.

Table 4.3.12-1. Pike County Jurisdictions in the 50-Mile Ingestion Exposure Pathway Zones

Jurisdiction	50-Mile Ingestion Exposure Pathway Zone – Susquehanna	50-Mile Ingestion Exposure Pathway Zone – Indian Point
Blooming Grove Township	No	No
Delaware Township	No	Yes
Dingman Township	No	Yes
Greene Township	Yes	No
Lackawaxen Township	No	No
Lehman Township	No	Yes
Matamoras Borough	No	Yes
Milford Borough	No	Yes
Milford Township	No	Yes
Palmyra Township	Yes	No
Porter Township	No	No
Shohola Township	No	Yes
Westfall Township	No	Yes

The U.S. Department of Energy transports used nuclear fuel to the repository by rail and road, inside sealed containers. The used fuel may be shipped along specified highway routes. Rail is used to transport nuclear waste as well (Nuclear Energy Institute 2016). A concern for Pike County is the transportation of spent nuclear fuel rods from Indian Point. The County indicated that these fuel rods are transported in unmarked containers via rail every few years and pose a hazardous materials in-transit threat to Pike County.

**Range of Magnitude**

Plume Exposure Pathway EPZ refers to whole-body external exposure to radiation from a radioactive plume and from deposited materials and inhalation exposure from the passing radioactive plume. The duration of primary exposures could range in length from hours to days. The Plume Exposure Pathway EPZ does not reach Pike County. The 50-mile Ingestion Exposure Pathway EPZ refers to exposure primarily from ingestion of water or foods such as milk and fresh vegetables that have been contaminated with radiation. This kind of exposure can stem from any of the three categories of nuclear accident. Although the 50-mile Ingestion EPZs include only portions of Pike County (refer to Figure 4.3.12-1 and Table 4.3.12-1), impacts are anticipated across the entire County.

Nuclear facility accidents are classified into three categories, and exposure to radiation can stem from any of the three:

- Criticality accidents: Involves loss of control of nuclear assemblies or power reactors.
- Loss-of-coolant accidents: Occurs whenever a reactor coolant system experiences a break or opening large enough so that the coolant inventory in the system cannot be maintained by the normally operating make-up system.
- Loss-of-containment accidents: Involves the release of radioactivity from materials such as tritium; fission products; plutonium; and natural, depleted, or enriched uranium. Points of release have been containment vessels at fixed facilities or damaged packages during transportation accidents.



In accordance with regulations specified by FEMA and NRC, each facility is required to notify jurisdictional agencies of an incident or occurrence within that facility. NRC uses four classification levels for nuclear incidents (NRC 2008). PEMA and facility owners with whom PEMA coordinates use the following notification levels based on an internal trigger:

- **Unusual Event:** Incidents are occurring or have occurred that indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring off-site response or monitoring is expected unless further degradation occurs.
- **Alert:** Incidents are in process or have occurred that involve actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the U.S. Environmental Protection Agency (EPA) Protective Action Guides (PAG).
- **Site Area Emergency:** Incidents are in process or have occurred that resulted in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed EPA PAGs except near the site boundary.
- **General Emergency:** Incidents are in process or have occurred that have caused actual or imminent substantial core damage or melting of reactor fuel with potential for loss of containment integrity. Radioactive releases during a general emergency can reasonably be expected to exceed the EPA PAGs over more than the immediate site area.

After a nuclear incident, the primary concern is the effect on the health of the population near the incident. The duration of primary exposure could range in length from hours to months depending on the proximity to the point of radioactive release. External radiation and inhalation and ingestion of radioactive isotopes can cause acute health effects (e.g. death, severe health impairment), chronic health effects (e.g. cancers) and psychological effects.

Potential environmental impacts specific to the 50-mile Ingestion Exposure Pathway EPZ, and therefore of most concern to Pike County, include the long-term effects of radioactive contamination in the environment and in agricultural products. Pike County can expect some radioactive contamination in very small amounts in the case of a nuclear incident. This is not a significant concern in terms of external exposure and immediate health risks, but even a small amount of radiation will require the protection of the food chain, particularly milk supplies. Small amounts of radiation ingested over time could lead to future health issues. As a result, in the case of a nuclear incident, foodstuffs, crops, milk, livestock feed and forage, and farm water supplies will need to be protected from and tested for contamination. Additionally, spills and releases of radiologically active materials from accidents can result in the contamination of soil and public water supplies.

The worst-case scenario nuclear incidents for Pike County would be if a General Emergency occurred at Indian Point Power Plant that leaked sufficient radiation to create longer-term damage in the form of contaminated water, soil, and food supplies in the county. In addition, New York State residents may enter Pike County in search of a new residence or for medical care thus overwhelming existing community facilities and services.

### Past Occurrence

Pennsylvania is home to the only recorded nuclear emergency in the United States. In 1979, the Three Mile Island Nuclear Generating Station declared a general emergency following an internal system failure. Repercussions from this event were swift, with sweeping changes to NRC oversight that included assignment of responsibility to FEMA for outside support. Growth in the nuclear power industry immediately slowed, with the number of facilities decreasing over the next decade. In addition, public confidence in the nuclear industry decreased considerably.



While reports show conflicting information regarding medical impacts on the residential population following the disaster, costs of the cleanup phase of this incident exceeded \$1 billion. No FEMA disaster declarations have since occurred regarding nuclear emergencies in Pennsylvania.

### Future Occurrence

Pennsylvania is home to the only nuclear power plant General Emergency in the nation. Since the Three Mile Island incident, nuclear power has become significantly safer and is one of the most heavily regulated industries in the nation. Despite the knowledge gained since then, there is still the potential for a similar accident to occur again at one of the five nuclear generating facilities in the Commonwealth. The Nuclear Energy Agency of the Organization for Economic Co-Operation and Development notes that studies estimate the chance of protective barriers in a modern nuclear facility at less than one in 100,000 per year (Pike County HMP 2012).

Across the United States, a number of *Unusual Event* and *Alert* classification level events occur each year at the 100+ nuclear facilities that warrant notification of local emergency managers. Of these, *Alert* emergencies occur less frequently. For example, in 1997, there were forty notifications of *Unusual Events* and three *Alert* events nationwide. Based on historical events, *Site Area Emergency* and *General Emergency* incidents are very rare (Pike County HMP 2012). Based on available historical data and the lack of nuclear incident events impacting Pike County, the future occurrence of nuclear incident events can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

### Vulnerability Assessment

Effects from a radiological incident at a fixed facility would vary depending on the product released (type of radiation), amount of radiation released, current weather conditions, and time of day. The priority following an incident at any of the facilities within the Commonwealth of Pennsylvania is the life and safety of all individuals within the area impacted. Secondary to health and safety would be effects on critical infrastructure, environment, property, and the economy.

Contamination of agriculture, livestock, and production can lead to loss of commerce with other regions of the State, country, and even the world. Recently, many countries halted imports of products from Japan for fear of contamination following the tsunami-related nuclear incident at the Fukushima Power Plant. This loss in revenue compounded losses that Japan and its region were already encountering following the initial disaster.

Impacts within the affected area can include loss of utility service, contamination of local crops and livestock, loss of residential property due to measurable quantities of nuclear materials, and increased risk to health and wellbeing of individuals within the area.

Only portions of Pike County are located within the Ingestion Pathway EPZ of the Susquehanna Steam Electric Station or Indian Point Power Plant. Thus those municipalities more vulnerable to the contamination effects of nuclear incidents include Palmyra and Greene Townships for the Susquehanna Steam Electric Station and Shohola, Westfall, Milford, Dingman, Delaware, and Lehman Townships and Matamoras and Milford Boroughs for the Indian Point Power Plant. The number of structures and critical facilities within the 50 mile EPZ of each power plant is displayed in Table 4.3.8-2.



Table 4.3.12-2. Structures and Critical Facilities with the 50 mile EPZ of Power Plants.

Municipality	Addressable Structures in 50 mile EPZ of Indian Point Power Plant (NY)	Total Critical Facilities in 50 mile EPZ of Indian Point Power Plant (NY)	Addressable Structures in 50 mile EPZ of Susquehanna Power Plant (PA)	Total Critical Facilities in 50 mile EPZ of Susquehanna Power Plant (PA)
Blooming Grove Township	0	0	0	0
Delaware Township	1,021	3	0	0
Dingman Township	1,906	4	0	0
Greene Township	0	0	2,834	5
Lackawaxen Township	0	0	0	0
Lehman Township	0	0	0	0
Matamoras Borough	972	8	0	0
Milford Borough	718	13	0	0
Milford Township	784	6	0	0
Palmyra Township	0	0	707	0
Porter Township	0	0	0	0
Shohola Township	231	1	0	0
Westfall Township	1,175	13	0	0
<b>Pike County (Total)</b>	<b>6,807</b>	<b>48</b>	<b>3,541</b>	<b>5</b>

Source: HAZUS MH v3.1

As stated in Section 4.3.8.2, the County’s primary vulnerability to nuclear incidents comes in the form of food, soil, and water contamination. In terms of vulnerable land, the approximately 28,000 acres of farmland is vulnerable to radiological contamination in a nuclear incident. In 2007, the market value of all agricultural products of these farms totaled approximately \$3 million. While unlikely that all agricultural products would be lost in the event of a nuclear incident, the County can expect some portion to be lost. Time of year also impacts the vulnerability and losses estimated for a nuclear incident; an incident that occurs during the prime growing and harvesting season will have a larger impact on the County.

It is important to note that the entire County, not just the areas in the EPZ may be impacted based on the flow of goods and services and where residents get their food supply. Water contamination is also a concern in nuclear incidents. Public water suppliers that operate in or provide water to the County, coupled with the County’s 8,255 domestic drinking water wells, are all vulnerable to the effects of a nuclear incident.