THE BEST EMERGENCY PLAN

FOR INDIAN POINT, REV. 2

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ABOUT THE AUTHOR

Herschel Specter, President of Micro-Utilities, Inc., holds a BS in Applied Mathematics from the Polytechnic Institute of Brooklyn and a MS from MIT in Nuclear Engineering. He is a Licensed Professional Engineer in the State of New York. He has had a long association with the Indian Point nuclear power plants starting as a member of the Atomic Energy Commission (now the Nuclear Regulatory Commission) where he was the Licensing Project Manager for the original licensing of the Indian Point 3 nuclear plant in the 1970s. In the 1980s the New York Power Authority hired Mr.Specter to manage the defense of Indian Point 3 in a federal adjudicatory trial in the wake of the Three Mile Island nuclear accident in Pennsylvania. Prior to joining NYPA, Mr. Specter served at diplomat rank for 5 years at the International Atomic Energy Agency in Vienna, Austria where he headed up an international effort writing design safety standards for nuclear power plants.

Mr. Specter has been Chairman of two national committees on emergency planning and was a guest lecturer for several years on emergency planning at Harvard's School of Public Health. He led an effort as a consultant to Entergy analyzing emergency responses during a hypothetical terrorist attack on Indian Point. Mr. Specter has presented testimony at the National Academy of Sciences on the Fukushima accident and on other nuclear safety matters and has been a guest speaker at many universities on matters of energy policy. Today he is one of 14 Topic Directors in Our Energy Policy Foundation, a group of about 1500 energy professionals who seek to bring unbiased and comprehensive energy information to our political leaders and members of the public.

Mr. Specter has been active on social and environmental matters. He has been a Big Brother and in 1971 had the honor of being selected as "Big Brother of the Year" for all of the USA and Canada. He also received a personal letter of commendation from the President of the United States for his work with the Youth Conservation Corps.

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1.0 Executive Summary

New York State is at a crossroads because of the Indian Point Nuclear Power Plants. Today, the principal reason for the State to close Indian Point units 2&3 is the perception that, in the event of a nuclear accident, no practical emergency response could be taken. The opposite is true. New York State could have at Indian Point the best nuclear emergency plan in the nation: a plan that is simple, yet highly effective; a plan where an accident would have near zero offsite radiological consequences; a plan that has been tested and proven in an actual nuclear accident situation where the area near the plant was experiencing extreme emergency response conditions; a plan that people could have confidence in. Not only is this emergency plan highly effective for rare nuclear accidents, near zero offsite radiological consequences would also be expected if this plan were applied during a willful major act of terrorism.

The dominant justifications for replacing Indian Point is the large population surrounding Indian Point and the false claim that Indian Point lacks adequate evacuation routes.As this report shows, Indian Point always had adequate evacuation routes. These evacuation routes are the actual road system within a short distance, a few miles, of the Indian Point site. These local routes have been analyzed in great detail, as described here. Not only are these evacuation routes well known, it has been determined that their rectangular grid is very beneficial to minimizing radiation risks. The question now is whether our State government leaders will use this information to make evidence-based decisions or bend to debunked fear mongering.

2.0 Background

This report describes how the present emergency plan at Indian Point could be improved and could well become the best emergency plan in the nation. In contrast to this simple and highly effective emergency plan, this report also describes three extreme emergency responses. One such extreme emergency response assumes a twenty million person, 50 mile radius evacuation, a second emergency response assumes that people near Indian Point would stay out-of-doors for 48 hours during a hypothetical accident, and the third assumes that a successful terrorist attack had occurred at Indian Point. Unlike the first two extreme emergency responses which do not have a credible scientific basis, the terrorist attack analysis is based on advanced emergency response technology.

The place to start is with the present emergency plan at Indian Point. While the present Indian Point Emergency Plan is quite protective of the public, there is room for improvement. The result of implementing the five overall improvements presented here would be a simple, but highly effective and proven emergency plan: Evacuate the innermost two miles prior to the release of radioactive material into the environment; if a release actually occurs, shelter downwind beyond these innermost two miles; and later, relocate people out of hot spots, if any. Additional details are given in Section 3. The five suggested improvements to the present Indian Point emergency plan are:

1. Evacuations should be limited to the innermost 2 miles. Downwind sheltering beyond two miles should take place if a radiological release has actually started. Most people would not be in the radioactive plume pathway and they would not be radiologically affected by the accident. Everyone should listen to official emergency instructions and information.

2. The whole bus/evacuation route process should be refocused to concentrate on people within the innermost two miles from Indian Point who need transportation support.
3. The timing of when the director of the emergency response issues an order to evacuate the innermost two miles and later to order downwind sheltering, merits re-examination.
4. The plan should prepare for the potential relocation and sheltering of those people in radiological hot spots caused by an accident, even if these people reside beyond the present 10 mile Emergency Planning Zone (EPZ). There is ample time to relocate people from hot spots.
5. A significant effort should be made to inform the public and their elected officials about this outstanding emergency plan and the fact that Indian Point represents a far smaller risk than many have been led to believe.

3.0 The Nation’s Best Nuclear Emergency Plan

3.1 Introduction

If the improvements in Indian Point’s emergency plan described below were implemented and communicated to the public, it should be an emergency plan people would have confidence in. **It could very well become the best nuclear emergency plan in the nation.** With such a plan, zero near term radiation-caused fatalities would be expected if a very rare nuclear accident occurred. Likewise, zero radiation-caused sicknesses would be expected. Long term consequences, if any, would be too small to be detectable. Non-radiological consequences from an accident at Indian Point would also be minimized, and perhaps eliminated, because about 95% of the Indian Point Emergency Planning Zone (EPZ) population would not be advised to evacuate, but rather to take downwind shelter or stand by if not downwind.

Public acceptance of Indian Point might increase if the public became aware how unlikely a reactor melt down is, in the range of one chance in a hundred thousand per year per plant, and that there are multiple and diverse layers of protection. In addition to all the active safety equipment like pumps, valves, sprays, emergency diesel electricity generators, etc. that are designed to prevent or mitigate a core melt accident, there is a second layer of public protection, the containment buildings. These robust structures offer passive safety protection and do not need electric power or any active safety equipment or actions by plant personnel to greatly limit the amount of radioactive material that might be released into the environment. There is then a third layer of public protection, the emergency response plan, the subject of this report. This third layer of protection itself is quite conservative. In an accident an all-sheltering emergency response could be justified because the radioactive material releases into the environment would be very small. However, nuclear safety philosophy calls for further defense-in-depth. Therefore a mix of in-close evacuation prior to the release of radioactive material combined with downwind sheltering, if a release actually occurs, forms the basis of this highly effective emergency plan. Such a plan is simple and was proven to be highly effective even under the extreme emergency response conditions experienced at Fukushima where there was a magnitude 9 earthquake, a towering tsunami, and widespread power outages. By limiting the order to evacuate to the innermost two miles, the financial burdens on the public and their local governments could be sharply reduced. There would be no need to support very large numbers of people taking shelter, many of whom may choose, out of unjustified fears, to continue to remain in the shelters for very long times. An improved emergency plan at Indian Point would be applicable to all the nuclear plants in New York and could possibly serve as a model for nuclear plants across the nation.

3.2 Specific Improvements Recommended for the Indian Point Emergency Plan

Implementing the improvements detailed below would convert the present adequate emergency plan at Indian Point to perhaps the best nuclear emergency plan in the nation:

- Evacuations should be limited to the innermost 2 miles. About 5% of the EPZ population (around 20,000 people) live within 2 miles of the Indian Point site. Evacuating 20,000 people is one thousandth the number of people within 50 miles of the Indian Point site that the public has been falsely told would have to be evacuated.

- The present plan includes bus routes where people are supposed to stand outside and wait to be transported further away from the Indian Point site. Many of these bus routes are beyond the innermost two miles and incorrectly convey the message that evacuation from these more distant locations is the preferred emergency response. If people were waiting outside for a bus and were in the plume deposition area, this would increase these people’s exposure to radiation. The whole bus/evacuation route process should be focussed on serving people in the innermost two miles who need transportation support.

- The times when the authority leading the emergency response issues the order to evacuate and, later, to order sheltering for those people downwind and beyond the innermost two miles, merits re-examination. If possible, these two orders should be separated by several hours. With regard to the second order, there would be long periods of time between the initiation of a hypothetical accident at Indian Point and any release of radioactive material into the environment. The general direction of the plume might not be precisely known until the release actually begins. If the order for downwind people to take shelter is issued soon after the evacuation order this could lead to some people evacuating from unaffected areas and then seeking shelter. Needless sheltering puts a much greater and unnecessary burden on local governments to provide public sheltering and other support services. There also is the concern that some people, contrary to orders, may evacuate from unaffected areas during the time when people within two miles of the site should be evacuating, causing a slowdown of those that need to evacuate this innermost area.

- More attention should be paid to people beyond the 10 mile EPZ if an accident causes hot spots beyond the EPZ. If such hot spots occur and projected dose rates are higher than NRC relocation criteria, then people in these hot spots should be relocated until dose rates decrease to acceptable levels. Note that there would be ample time to locate such hot spots, if any, and then relocate people. As shown in TABLE A-1, the Japanese took three months to relocate people from hot spots using a relocation criterion of 20 milisieverts (mSv) per year. This is a very low dose rate. A multiple scan average dose from a cranial CT is about 50 mSv which is delivered over a much shorter time span than one year.

There is an additional non-radiological benefit to incorporating long term relocations from possible hot spots beyond the 10 mile EPZ. Over the years some people who live beyond Indian Point’s

10 mile EPZ have worried that they might be ignored should an accident occur. By explaining to the public that relocation from hot spots, even if beyond the 10 mile radius EPZ, is incorporated into an enhanced emergency plan at Indian Point, this kind of worry may be alleviated.

- A significant effort should be made to inform the public and their elected officials about this improved emergency plan and the fact that Indian Point represents a far smaller risk than many have been led to believe.

4.0 Nuclear Power in New York State

At this time New York State has six operating carbon-free nuclear power plants that supply about 32% of the State's electricity. Four of these nuclear plants are located upstate and two, Indian Point 2 (IP2) and Indian Point 3 (IP3), are located downstate in Westchester County. According to Mr. Kevin Wisely, ***"The Department of Public Service (Department) agrees that zero-emissions attributes of nuclear facilities is beneficial. The Department views the continued use of nuclear power a crucial element in the strategy to fight climate change and achieve New York State's commitment to reduce carbon emissions."***[1]

However, IP2 is scheduled to close on April 30, 2020 and IP3 a year later on April 30, 2021. The principal reason given for maintaining the four upstate nuclear plants while closing IP2 and IP 3, is the much higher population density surrounding these two downstate plants. As stated by Mr. Wisely, ***"...and the fact that the site is located in a densely populated region lacking evacuation routes in the event of a disaster remain a concern of the State".***[2]

Similar concerns have been expressed elsewhere. For example, in an Issue Brief written by the Natural Resources Defense Council (NRDC) justifying the closure of IP2 and IP3, it was stated that ***"... based in part on its proximity to New York City - making emergency evacuation all but impossible..."***[3]**.**

5.0 Views of Professional Nuclear Emergency Planners

For years the public has heard that there are about 20 million people within 50 miles of Indian Point, making evacuation of this huge area during an accident near impossible. Interestingly, professional nuclear emergency planners would also be opposed to any massive evacuation scheme involving the 20 million people within a 50 mile radius of Indian Point, <u>even if such a massive evacuation might be achievable.</u>

Opposition by professional nuclear emergency planners to any massive evacuation scheme has its roots in emergency planning guidance given years ago by the Environmental Protection Agency (EPA). The EPA guidance is straight forward. It recognizes that, in a nuclear emergency, there are two types of risks: radiological risks and the non-radiological risks that the emergency response itself might create while in the process of trying to reduce the radiological risks. The EPA guid-

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[1] Letter from Kevin Wisely, Director, Office of Resilience and Emergency Preparedness, New York's Department of Public Service, to Dr. Alexander Cannara, June 3, 2019.

[2] Ibid, page 1.

[3] "Transitioning Away From Uneconomical Nuclear Power Plants", Dale Bryk and Jackson Morris, Natural Resources Defense Council (NRDC), November, 2018, page 4.

ance encourages emergency plans that minimize the sum of the radiological risks and the non-radiological risks. By radiological risks or consequences, we are referring to two near term (within 60 days of the accident) radiological consequences and one long term radiological consequence that might occur years after the accident. The near term consequences that emergency plans are designed to eliminate or reduce are radiation induced fatalities and radiation sicknesses, while long term radiation effects would be latent cancer fatalities.

We know today that, in the United States, radiological risks from a nuclear accident are near zero and far smaller than the non-radiological risks.

6.0 Lessons Learned From the Fukushima Accident in Japan

Lessons learned from the Fukushima accident reinforce the conclusion that the radiological risks in a nuclear accident are near zero and far smaller than the non-radiological risks. Even though there were three simultaneous reactor meltdowns at Fukushima, a magnitude 9 earthquake, a towering tsunami, and widespread power outages, the emergency response under these extreme conditions at Fukushima led to **zero** near term radiation fatalities and **zero** radiation sicknesses. According to the World Health Organization and our National Academy of Sciences, long term cancer fatalities would be too small to be detectable even when estimated by a very conservative health effects computer model. About 18,000 people in Japan lost their lives to this earthquake and the ensuing tsunami and this can be compared to the zero fatalities at Fukushima from the nuclear accident. None of the containment buildings in the 50+ reactors in Japan failed from this magnitude 9 earthquake or the tsunami. If a very large earthquake struck the Westchester area, the robust Indian Point containment buildings would be among the only buildings standing, whereas the general public could experience a great loss of lives and property.

In contrast to the zero radiological consequences, over-evacuation and poor long term sheltering conditions at Fukushima have led to well over 1000 non-radiological fatalities. Because of orders by senior government decision makers, some Japanese citizens were rushed out of their homes, sometimes so abruptly they didn’t even have time to take along their medications, and placed into crowded shelters. There were great stresses on these people as they worried that they had been exposed to radiation, that their homes, farms, and ancient family burial sites going back generations were now lost to them forever, and from being packed into shelters with strangers. Later, when informed by government officials that it was safe to return to their homes, many out of fear and mistrust of the government, refused to leave these shelters to return home. Three years after the Fukushima accident, about 80,000 people were still in shelters.

So the Japanese emergency response to the three Fukushima meltdowns did not follow the EPA guidance. It was a great success in eliminating the radiological risk and a failure in minimizing the non-radiological risk.

Attempts to evacuate 20 million people within a 50 mile radius of Indian Point is almost certain to have zero or near zero radiological consequences, but potentially high non-radiological consequences. This is inconsistent with EPA guidance. For this reason professional nuclear emergency planners would also oppose any 50 mile evacuation scheme.

TABLE A-1 provides a chronology of emergency responses at Fukushima as compiled by our National Academy of Sciences[4]. The huge magnitude 9 earthquake struck at 14:46 on March 11, 2011 and was followed by two waves of tsunamis, the first of which struck Fukushima at 15:24 on March 11th and the second wave at 15:36-15:37. By 20:50 on March 11 the first order to evacuate the innermost 2 kilometers was given. The first indication[5] of a release of radioactive material into the environment was 8.2 hours after the earthquake, i.e. about 23:06 on March 11th. As shown in TABLE A-1 the order to evacuate the innermost 3 kilometers was given before the first release started. Because the range of the near term fatality risk is between zero and one mile and the radiation sickness range is between zero and two miles, if evacuation of the innermost 3 km (~ 2 miles) is implemented prior to a release there will be no near term fatality or radiation sickness consequences.Therefore just evacuating the innermost two mile area surrounding a nuclear plant prior to the release of radioactive material profoundly reduces near term radiological risks and consequences.

TABLE A-1 Emergency Responses at Fukushima

Time in year 2011	Distance from plant, kilometers	Emergency response action
March 11, 20:50	2	Compulsory evacuation
March 11, 21:53	3	Compulsory evacuation
March 12, 05:44	10	Compulsory evacuation
March 12, 18:25	20	Compulsory evacuation
March 15	20-30	Shelter at home
March 25	20-30	Self-evacuate
April 22	Areas with doses greater than 20 mSv/year.	Evacuate within one month
June 16	Hot spots with doses greater than 20 mSv/year.	Special spots recommended for evacuation

7.0 Alternative Emergency Responses

Since both those who support the continued operation of Indian Point and those that are opposed to it are in agreement that any massive 50 mile evacuation scheme should be avoided, alternative emergency responses are now examined here.

[4] Derived from TABLE 6.1 of “Lessons Learned From the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants”, National Academy of Sciences, 2014.

[5] Ibid, TABLE 4.1.

7.1 The NRDC Emergency Response Analysis of Indian Point

The NRDC conducted a series of analyses[6] where a severe nuclear accident was assumed to occur at Indian Point. Figure A-1 reproduces a figure from one of these analyses, as published on the Riverkeeper website. The NRDC analyses are the complete opposite emergency response compared to a massive 50 mile evacuation. Here people are assumed to be stationary, standing out-of-doors for 48 hours while the accident is proceeding.

There are several significant defects in this NRDC analysis, discussed later, all of which result in overestimating the radiological consequences. In spite of these defects, this long lasting stationary kind of response would be an improvement over a 50 mile evacuation response:

1. First, since people would be stationary during the accident this would minimize the non-radiological consequences of over-evacuation.
2. Second, it is noted that only a fraction of the 50 mile radius area is affected by this hypothetical accident. People outside of the affected area (the plume deposition area) are free to move about, take shelter, or take any other normal activity since they are not at risk. They need only listen to instructions from emergency response personnel. This NRDC analysis shows that within the 50 mile radius circle, only the people within the affected area might have to be evacuated, not all 20 million people. The other analyses in this NRDC series on Indian Point also show that far fewer than 20 million people would be in the plume deposition area. So there is a disconnect between a 50 mile circle area and the need to evacuate the 20 million people within this 50 mile circle.
3. Third, this NRDC analysis does not indicate any near term fatalities in spite of people standing out-of-doors for a prolonged period of time and a grossly overstated release of radioactive material (discussed later). This absence of any near term fatalities is consistent with the zero near term fatality radiological consequences observed at Fukushima. Zero near term fatalities are the expected result of nuclear accidents if there are wind shifts during the release of radioactive material into the atmosphere. The NRDC analysis maximized the size of the affected area by including wind shifts, but in doing so they eliminated the possibility of causing an early fatality, even with their overstated release of radioactive materiel and with their highly unrealistic standing out-of-doors for 48 hours emergency response.
4. Fourth, only a very small area, shown in brown in this NRDC analysis, meets the threshold for radiation sickness. As stated before, the range of the near term fatality risk is zero to one mile from the point of release. The range of near term radiation sickness is zero to two miles. The small radiation sickness area in Figure A-1, also quite close to the Indian Point site, supports this limited range. With all the near term radiation effects confined to an area within two miles of the point of release, there are no near term radiological benefits of evacuation beyond these innermost two miles. It would not matter if the assumed evacuation area had a ten mile radius, a 50 mile radius, or even a 100 mile radius in terms of affecting the near term radiological fatality and sickness risks.The real effect of a highly oversized evacuation is to increase the non-radiological risk. Over-evacuation adds to the public’s risks.

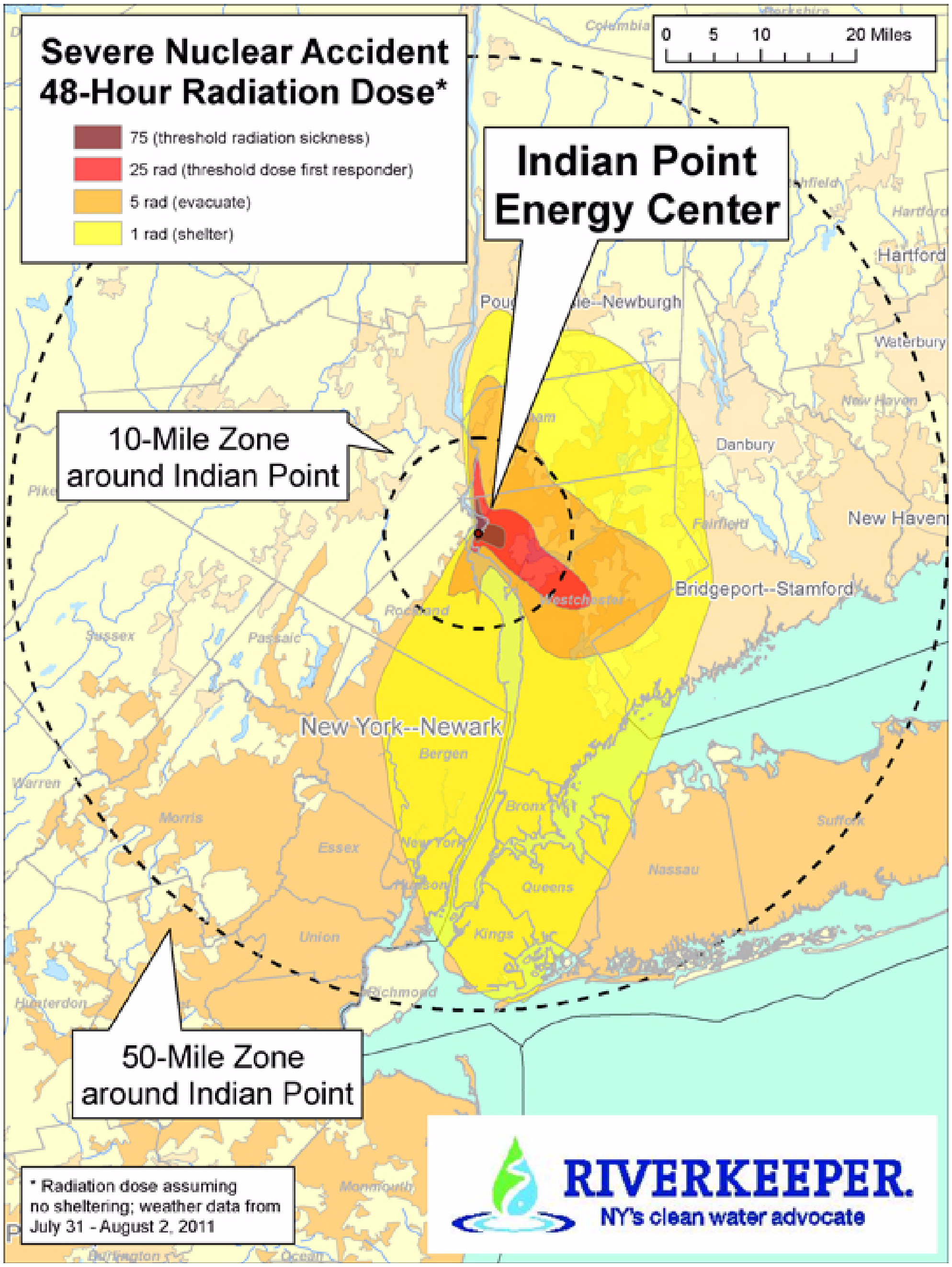
[6] “Nuclear Accident at Indian Point: Consequences and Costs”, M. McKinzie and C. Paine, NRDC, October, 2011.

5. Fifth, this NRDC analysis shows is that, for a variety of reasons, the near term radiological risks from nuclear accidents are expected to be near or at zero, regardless of any assumed difficulties associated with implementing a massive evacuation. The NRDC analysis, inadvertently, proved that Mr. Wisely's concern about inadequate evacuation routes does not translate into near term radiological consequences. In the NRDC analysis there were no evacuation routes and, yet, there were zero calculated near term radiation fatalities. This conclusion is further demonstrated in the science-based analysis of hypothetical terrorist attacks, discussed later in this report.

7.2 Conclusion

The important evacuation routes are those within a few miles of the Indian Point site, not up to 50 miles away. Even if there were no evacuation routes, zero near term fatalities would be expected if an accident occurred.

FIGURE A-1 NRDC Analysis of Indian Point



7.3 Improving the NRDC Analysis.

There are two major defects in the NRDC analysis of Indian Point.

7.3.1 Out-of-Doors for 48 Hours

The most obvious defect in the NRDC analysis is that people do not stand out-of-doors for 48 hours in a row, particularly during a fearful nuclear accident. EPA guidance calls for responses like sheltering or evacuation or some combination of the two, not multi-hour unprotected exposure. Not only is the basis of the NRDC analysis of people standing out-of-doors for 48 hours unrealistic, people would be better off if they just ignored all the sirens and messages from the Emergency Broadcast System and went about their normal activities. Normal activities include a fair amount of time indoors, which would provide some level of shielding and dose reduction. If downwind people took shelter, as described in their emergency booklets or called for on the Emergency Broadcast System, even the small radiation sickness area in the NRDC analysis would be eliminated and doses throughout the whole downwind area would be lower.

The absurd idea that people would stand out-of-doors for 48 hours should be enough to reject the whole NRDC analysis. No governmental decision to close Indian Point should be based on this obvious absurdity.

7.3.2 The Size of the Release of Radioactive Material

The most important parameter for determining offsite radiological consequences from a nuclear plant accident is the amount, type, and timing of radioactive material released into the environment, also known as the source term. Source term analyses have evolved considerably and in 2012 one of our National Laboratories, the Sandia National Laboratory, published its highly peer reviewed results of its SOARCA effort[7] (State-of-the-Art-Reactor Consequence Analyses). TABLE A-2 lists the results[8] of two station blackout (no onsite or offsite electricity) sequences for a nuclear plant which has a **containment structure similar to those at IP 2 & IP 3.** Station blackout sequences were chosen because the three Fukushima meltdowns were all blackout sequences and they are major contributors to calculated nuclear risks. TABLE A-2 lists SOARCA calculated results for radioactive iodine and cesium in terms of release fractions. A release fraction is the amount of iodine, or cesium, that enters the environment divided by the amount of iodine, or cesium, in the reactor core at the time of the accident initiation. For example, a release fraction of 0.10 for element X means that 0.10, or 10%, of the original number of kilograms of element X in the reactor core at the beginning of an accident sequence ended up being released into the environment.

These SOARCA results indicate that only very small amounts of radioactive iodine and cesium would enter the environment if an accident occurred at Indian Point. Such small releases would not be able to cause any near term radiological health effects regardless of the type of emergency response or lack thereof. Further, if it were decided to evacuate the innermost two miles prior to

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[7] See NUREG 1935 and NUREG -7110, Volume 2.

[8] Derived from NUREG-1935, TABLE 7-1.

the release of any radioactive material, there would be 25.5 to 45.3 hours from the start of the accident sequence to accomplish this. These time periods between accident initiation to the release of radioactive material into the environment are much longer than those observed at Fukushima because the volumes of the containment buildings like those at Indian Point are much larger than the Fukushima containment buildings. The much larger volumes in containment buildings like those at Indian Point cause internal containment pressures to rise more slowly, extending the time in an accident when significant leakage might occur.

TABLE A-2 SOARCA Source Term Release Fractions

Accident scenario	Iodine release fraction	Cesium release fraction	Release start, hours after accident initiation	Release end, hours after accident initiation
Short term station blackout	0.006	0.001	25.5	48.0
Long term station blackout	0.006	0.000	45.3	72.0

7.3.3 Comparison of SOARCA to NRDC Source Terms

The NRDC nuclear accident release fractions are significantly larger than those calculated by our national laboratories when using the SOARCA computer code. Specifically, the iodine release in the NRDC analysis is 138 times larger than SOARCA's and the cesium release 1,278 times larger. The NRDC analyses referenced in footnote 6 assumed three separate releases to the environment, one called the gap release, a second when there was a core melt within the reactor vessel (in-vessel release) and a third when there was a vessel melt through. TABLE A-3 is a compilation of the iodine and cesium releases that the NRDC used in its analysis.

TABLE A-3 NRDC Source Term Release Fractions

	Gap release	In-vessel release	Vessel melt through release	Total release to the environment
Iodine	0.038	0.30	0.49	0.828
Cesium	0.038	0.55	0.69	1.278

Two observations can be made about the NRDC source terms for iodine and cesium. First, the cesium release fraction of 1.278 is physically impossible. No accident can release more than 100% of its initial inventory of any radioactive material. In the NRDC analysis 27.8% more cesium is assumed to be released into the environment than actually would exist within the nuclear reactor core. The NRDC has not offered any explanation for this number. Second, the NRDC source terms are much larger than those calculated by the SOARCA computer analysis.

7.3.4 Why are the NRDC Source Terms Much Too Large?

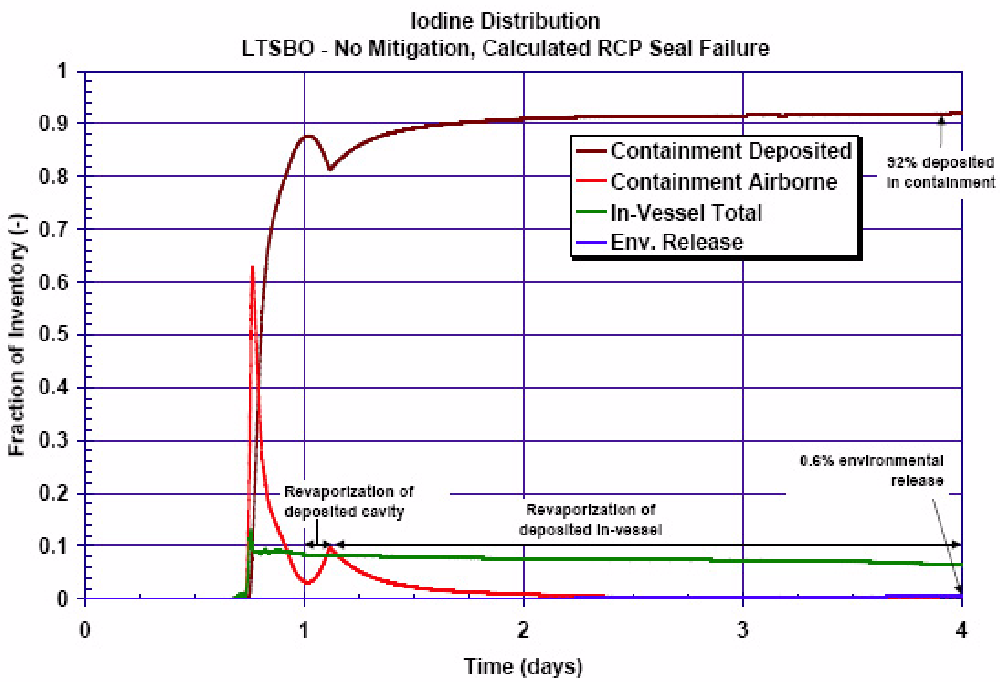
The NRDC analysis is based on source terms generated[9] by the Nuclear Regulatory Commission for accidents where the containment building remains intact. These NRC source term analyses are used to determine how rapidly various isolation valves must close to prevent radioactive material from entering the environment if an accident occurred. Section 5 of this NRC report describes "In-Containment Removal Mechanisms". For containment buildings like those at Indian Point there are a number of in-containment removal processes. These are natural processes that rapidly remove radioactive iodine and radioactive cesium from the air space within the containment. These natural removal processes include gravity, the plate-out of radioactive material on metal surfaces and the absorption of iodine and cesium by wet surfaces and in pools of water generated by the accident. Figure A-2, derived from SOARCA analyses, depicts the concentration of radioactive iodine in the containment air space for containments like those at Indian Point. Note that the iodine air borne concentration drops to very low levels before there is significant leakage from the containment. The airborne concentration of cesium acts in a very similar way; low levels are reached before there is significant leakage from the containment. In effect, these passive containment structures act as very effective filters, using natural forces to protect the public. No electric power or actions from plant operators are necessary for these natural forces to protect the public. No operator error or act of terrorism can defeat these natural forces.

The NRDC analysis did not account for these natural, protective processes. The NRDC analyses were equivalent to having a nuclear power plant without a containment structure. The NRDC analysis took the NRC report, NUREG-1465, which calculates source terms for an intact containment building, ignored the natural removal processes described in Section 5 of that report, and released the radioactive material into the environment without any filtering, as if the containment building did not exist.

It would be beneficial if the NRDC recalculated its analysis using the SOARCA source term. If this were done the very small area now identified as having radiation sicknesses within it would disappear and the area shown in yellow would shrink considerably. A second improvement in the NRDC analysis would be to follow the guidance in the insert in the upper left corner of Figure A-1 to take shelter in the yellow area. The combination of much smaller source terms and sheltering in the yellow area would likely eliminate any 5 rad area, thereby limiting evacuation to the innermost two miles.

[9] NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants", USNRC, February, 1995.

FIGURE A-2 Iodine Greatly Reduced Prior to Leakage



Unmitigated LTSBO iodine fission product distribution history

7.4 Analysis of a Hypothetical Terrorist Attack on Indian Point

7.4.1 Background

During the terrorist attack on 9/11 on the World Trade Center one of the attack planes flew rather close to the Indian Point site. This prompted many questions about what might have happened if this plane had rammed into Indian Point instead of the World Trade Center. Because of this concern, Entergy, owner of the Indian Point nuclear plants, funded a unique study[10] to analyze a hypothetical terrorist attack on Indian Point.

Two groups of experts were assembled. The first expert group, already quite familiar with the road system and population around Indian Point, analyzed how an evacuation of cars down the streets around Indian Point might proceed if this assumed terrorist attack took place. This expert team used very detailed data on population size and location, and precise configurations like actual road widths, highway ramp capacities, and many other Indian Point specific data. This advanced traffic analysis capability was also used as a search tool. It identified locations where the speed of an EPZ-wide evacuation could be increased by temporarily making specific evacuation routes one way and outward bound, should an attack actually occur. The second group of experts analyzed

[10] "Enhanced Emergency Planning", RBR Consultants, Inc., December, 2007.

how much, what type, and when radioactive material might enter the environment should the terrorists be successful in breaching the robust containment building and initiating a core melt sequence. This second group of experts then calculated the health consequences of such radioactive releases from this hypothetical terrorist attack. Two different core melt sequences were examined. One was a station blackout (SBO) sequence where it was assumed that all onsite and all offsite electric power was lost (similar to blackouts experienced during the Fukushima accident and to SOARCA SBO analyses). The other accident sequence assumed that the terrorists were able to break a major pipe in the reactor system causing a large loss of coolant (LOC sequence), simultaneous with disabling all the plant’s safety systems. Like the traffic analysis expert group, efforts were made by this second group of experts to use Indian Point specific data.They used meteorological data that had been collected at Indian Point over the years and shielding factors representative of structures in the Indian Point area, etc.

Two extremely conservative assumptions were then made. First, without attempting to identify how this might be accomplished, it was assumed that the terrorists first created a three square foot hole in the containment. Holes larger than three square feet would not particularly alter the release of radioactive material. Creating such a huge hole in a containment building like those at Indian Point is not a simple task. Experiments have been run where an F4 Phantom Jet was purposely rammed at high speed into a reinforced concrete barrier representing a portion of a containment wall. It failed to penetrate the containment wall. Second, it was assumed that the terrorists were able to overcome the resistance of armed security personnel at the nuclear plant and outside police and military forces, locate sensitive areas within the nuclear plant and then create a core melt sequence- all within one half hour. Assuming a very short time period to initiate a core melt situation is important. The longer it would take terrorists to initiate a core melt sequence, the larger the number of people within the innermost two miles that would have evacuated away from the plant and the more likely the terrorist activity would have been terminated by security forces. Delays in initiating a core melt sequence means that calculated near term radiological consequences would be smaller.

The two teams of experts worked together. The traffic experts determined where evacuees would be moment by moment. This was done for a variety of scenarios where the number of people assumed to be evacuating varied. The number of potential evacuees varies depending on the day of the week, the time of day, the season of the year, etc. Using the two different assumed sequences, SBO and LOC, the source term analysis group tracked where the hypothetical radioactive plume might be. They did this for many meteorological conditions. When a hypothetical radioactive plume intersected with evacuees projected to be moving along the actual road system around Indian Point, radiation exposures of the evacuees were calculated and these exposures were converted into calculated health effects.

7.4.2 Lessons Learned from this Hypothetical Terrorist Attack Analysis

Numerous lessons were learned from this unique study:

1. As would be expected, the assumed evacuation of all 366,800 people within the Indian Point EPZ (as of 2007) was calculated to be very slow, sometimes less than one mile per hour. Those evacuation scenarios where fewer than 366,800 people were assumed to evacuate were calculated to proceed more rapidly, as expected. These more rapid evacuations would occur if some fraction of the EPZ population took shelter and under

other circumstances, like during night time. A more rapid evacuation lowers exposure to radiation and calculated health consequences. This observation provides an additional reason to avoid a massive evacuation. The larger the evacuation, the slower the evacuation speed and the greater the radiation exposure of evacuees closest to the Indian Point site.

2. Numerous meteorological conditions were examined. It was learned that only a very narrow radioactive plume that did not shift directions for a considerable period of time might cause near term radiation health effects. Such a meteorological condition does not happen frequently. More frequent meteorological conditions, where the plume is wider and/or shifts in direction, are not capable of producing near term fatalities. This observation correlates with the zero fatalities calculated in the NRDC analysis which had significant wind shifts.
3. Even in the extreme SBO and LOC sequences analyzed in this report and the assumed 3 square foot hole in the containment, most of the radioactive iodine and cesium would be trapped inside the breached containment. (See TABLE A- 4). This trapping of the iodine and other fission products like cesium, was due to the natural removal processes described in Section 7.3.4 of this report.
4. The local, basically rectangular, road system near Indian Point is very beneficial. This road system forced cars to cross through the narrow radioactive plume more or less perpendicularly. Even though evacuation speeds were typically very slow, the time to cross through this narrow plume was short, a matter of a few minutes, thereby limiting radiation exposure. Less sophisticated accident analyses performed elsewhere typically model evacuations radially moving away from a site at a constant speed. When this is done nearly all the calculated near term fatalities are calculated to occur along the line where the narrow plume exists. The less accurate radial evacuation model was applied to Indian Point and consequences were compared to the consequences derived from the more precise evacuation modeling. The more accurate evacuation model used in this analysis led to far fewer calculated near term fatalities and radiation sicknesses.
5. There are multiple lessons here that relate to Mr. Wisely's concern about lacking evacuation routes:
    a. Evacuation routes beyond the innermost few miles, and especially at distances as large as 50 miles, have negligible effect on near term radiation of people near Indian Point.
    b. The actual evacuation routes around Indian Point are well known, have been closely studied, and are beneficial because they avoid a radial evacuation response. The most important evacuation routes are those closest to the Indian Point site.
    c. In an accident situation any evacuation route is acceptable if the releases of radioactive material are as small as the SOARCA program calculates. No evacuation routes are necessary to avoid near term radiation fatalities if there are wind shifts. This is shown in the NRDC analysis, where people were assumed to be stationary for 48 hours.
    d. Most people would not be within the plume deposition area, as shown in Figure A-1. They may just listen to the Emergency Broadcast System indoors, they may

choose to shelter, and they may choose to evacuate. None of these three possibilities requires a specific evacuation route to protect them because they are not at risk.

   e. Those people downwind of the Indian Point site who take shelter do not need a specific evacuation route because they are not evacuating.

6. The few near term radiation fatalities calculated in this hypothetical terrorist occurred within a mile of the Indian Point site and radiation sicknesses was predominantly within two miles.
7. In order for this hypothetical terrorist attack to cause a calculated near term fatality at Indian Point, many factors would have to come together, <u>all at the same time</u>: The terrorists would have to breach the containment building by creating a large hole in it; the terrorists would then have to gain access to critical areas within the Indian Point site; and then quickly initiate a core melt sequence before being dispatched by security forces, meteorological conditions would have had to create an infrequent narrow and steady plume, and the number of people evacuating would have to be the whole EPZ during peak day conditions so to create the slowest evacuation. Achieving any one of these conditions is unlikely; achieving all of them simultaneously would be near impossible.
8. There is a connection between this terrorist emergency response analysis and the proposed Best Emergency Plan for Indian Point for rare accidents. Beyond the innermost two miles, the best emergency plan for rare accidents calls for people to take shelter, if downwind, and all others not to evacuate but remain tuned in to the Emergency Broadcast System. The same instructions would be given to people if there were a major terrorist attack. If most people obeyed these orders, then evacuation speeds of those leaving the innermost two miles would be much faster and zero radiological consequences would be expected. Therefore, the Best Emergency Plan for Indian Point is suitable for both rare accidents and for willful major terrorist attacks.

7.4.3 Consequences

Under poor weather conditions, the calculated number of near term radiation fatalities for a massive 366,800 person evacuation for this hypothetical terrorist attack was 5 persons. Ninety five percent of the time the weather would be more favorable and fewer than 5 near term fatalities would be expected. If just 65% of the people up to 4 miles from the site followed instructions to take shelter, the calculated number of near term fatalities decreases to 2 persons.

One of the benefits of the actual road configuration around Indian Point is to reduce the number of calculated near term radiation fatalities. A comparison was made of the number of early health effects using the more traditional radial, constant speed evacuation model and the more sophisticated and accurate evacuation model presented here. The radial, constant speed, evacuation model calculated a hypothetical 124 near term fatalities during poor weather conditions compared to the a hypothetical 2 to 5 fatalities using this more technically advanced model. This more advanced computer model revealed the special benefits of the existing evacuation routes near Indian Point.

Long term health effects from radiation from this hypothetical terrorist attack were also estimated for the EPZ population, using a very conservative health effects model. It was calculated that this terrorist attack might increase the EPZ population's latent cancer risk by less than one tenth of one percent. Such hypothetical long term consequences would be spread out over many years and would not be statistically obvious. This is consistent with conclusions reached by the World Health Organization and by our National Academy of Sciences on the Fukushima accident that long term health consequences would be too small to be detectable.

8.0 Overall Conclusion

The two Indian Point nuclear plants are the largest source of carbon-free electricity in whole Lower Hudson valley. They are very safe. These plants provide 25% of New York City's and 25% of Westchester County's electricity. If closed, they will not be replaced by emissions-free electricity but rather with a fossil fuel, natural gas. Replacing Indian Point with gas will release at least 7 million metric tons of carbon dioxide into our atmosphere year after year. This huge annual release of a greenhouse gas will negate the recently passed CLCPA (Climate Leadership and Community Protection Act) even before it gets started. In order to prevent brownouts or blackouts much of this replacement gas will likely have to be burned in "peaker" plants in New York City, many of which are located in Environmental Justice areas.

The dominant justification for replacing Indian Point is the large population surrounding Indian Point and the false claim that Indian Point lacks adequate evacuation routes.As this report shows, Indian Point always had adequate evacuation routes and they are the actual road system within a short distance of the site. The question now is whether our State government leaders will respond to this information to make evidence-based decisions or bend to debunked fear mongering.

9.0 Appendix

9.1 Comparison of Source Terms

TABLE A-4 compares three sets of release fractions for iodine and cesium source terms. The first set is SOARCA's the source terms for short term and long term station blackout conditions (SBO) accidents where the containment, similar to Indian Point's, initially is intact and slowly reaches high internal pressures starting significant leakage. The second set of source terms is derived from the terrorist attack analysis. Results from an SBO sequence and from a loss-of-coolant (LOC) sequence are presented. Here the containment was assumed to have a three foot square hole in it right from the beginning of the analysis. Lastly, the NRDC source term is presented. In the NRDC analysis there was, effectively no containment and no reduction of iodine or cesium from natural forces within the containment.

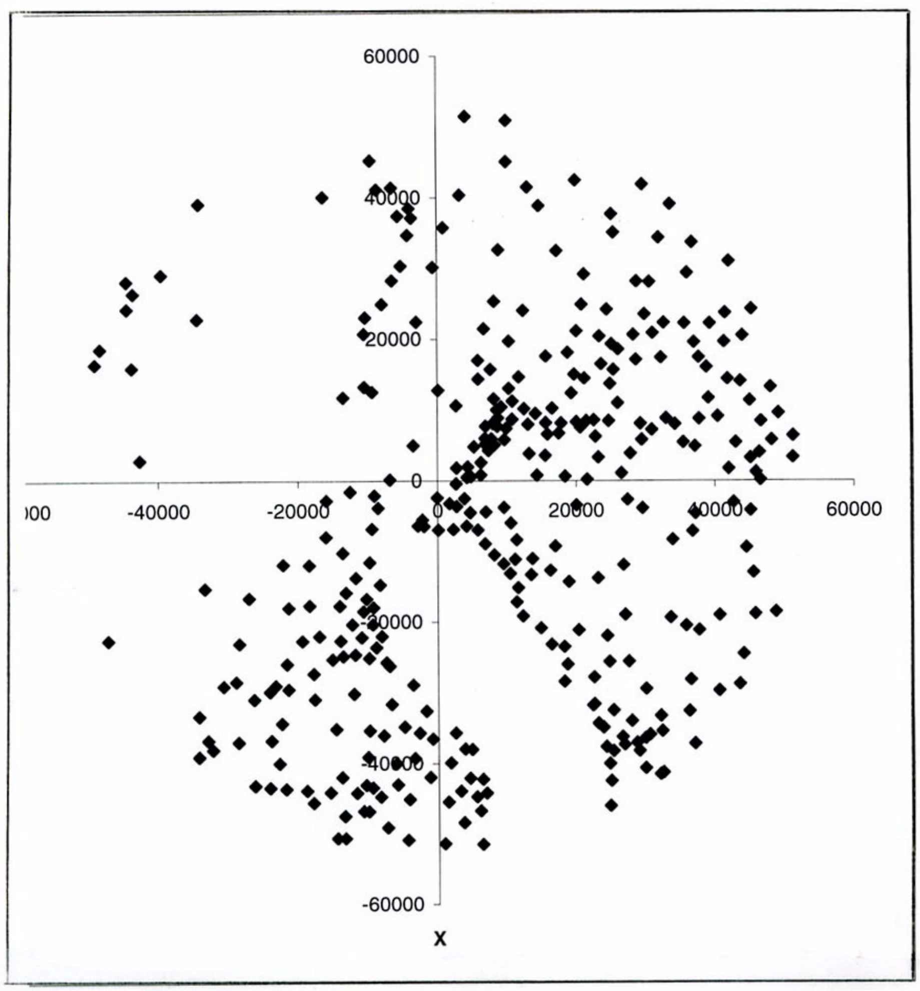
TABLE A-4 Comparison of Source Terms

	Iodine	Cesium	Containment
SOARCA Short Term SBO	0.006	0.001	Initially Intact
SOARCA Long Term SBO	0.001	0.000	Initially Intact
Terrorist Attack SBO	0.274	0.180	3 $ft.^2$ Hole Initially
Terrorist Attack LOC	0.111	0.101	3 $ft.^2$ Hole Initially
NRDC	0.828	1.278	No Effect on Source Term

9.2 Terrorist Attack Traffic Analysis Details

In order to give the reader a deeper understanding of the detail that the traffic analysis experts utilized in determining evacuation speeds and locations, Figure A-3 reproduces just one small piece of the input information used in their analysis. A very fine mesh was used in their analysis, 0.2 square miles, to gain a high level of precision. Many of these areas contain population centroids where people and vehicles are located. Some 357 centroids were used to describe where the population would begin their evacuations. Emphasis was placed on having a very fine mesh in the innermost four miles where radiation levels would be the highest. In Figure A-3 the X and Y coordinates are expressed in feet and the 0,0 coordinate is the Indian Point site.

FIGURE A-3 Location of Centroids Around Indian Point



9.3 Consequence Analysis Details

The source term expert group's analysis also was very detailed and used Indian Point specific data. One example of this is shown in Figure A-4 which is based on measured Indian Point wind shift data. This figure shows that the wind direction at Indian Point changes fairly frequently. As examples, there is over a 50% probability that the wind will shift one sector (22.5 degrees) in one hour and about a 20% probability the wind will shift three sectors in just one hour.

As discussed in the main text, it takes a narrow radioactive plume with a steady direction and a large release of radioactive material to possibly cause a near term radiation fatality. The meteorology of the Indian Point site, with its rather frequent wind shifts, make such conditions unlikely.

FIGURE A-4 Probability of Wind Shifts at Indian Point Versus Hours