RAS#284

# UNITED STATES
# NUCLEAR REGULATORY COMMISSION

## ATOMIC SAFETY LICENSING BOARD

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In re:

License Renewal Application Submitted by

Entergy Nuclear Indian Point 2, LLC,
Entergy Nuclear Indian Point 3, LLC, and
Entergy Nuclear Operations, Inc.

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Docket Nos. 50-247-LR; 50-286-LR

ASLBP No. 07-858-03-LR-BD01

DPR-26, DPR-64

August 28, 2009



## STATE OF NEW YORK'S
## MOTION FOR SUMMARY DISPOSITION
## ON USE OF STRAIGHT LINE GAUSSIAN AIR DISPERSION MODEL
## FOR THE ENVIRONMENTAL IMPACT ANALYSIS
## OF SIGNIFICANT RADIOLOGICAL ACCIDENTS AT INDIAN POINT
## AND NYS CONTENTION 16/16A

## TABLE OF CONTENTS

## TABLE OF AUTHORITIES

**Page**

**Judicial Decisions**



**Administrative Determinations**

## PRELIMINARY STATEMENT

More than 17 million people live within 50 miles of the Indian Point power reactors, the highest surrounding population of any nuclear plant. Numerous critical public and private institutions are also located in that 50-mile zone. For these reasons, it is imperative that the required environmental analysis of potential radiological emissions from the facilities be especially accurate.

Recently-obtained documents from the Nuclear Regulatory Commission (NRC) confirm that the central air dispersion model used by Entergy and NRC Staff in their environmental analysis is inappropriate for Indian Point given the site's complex terrain. These NRC documents reflect the scientific community's long-standing and broadly-held recognition that the straight line Gaussian model is appropriate only for relatively flat, homogenous terrain. Given this universal recognition of the inappropriateness of the model that forms the centerpiece of the analysis of radiological air emissions from Indian Point, the Board should grant summary disposition in favor of the State of New York on this aspect of Contention 16/16A.

To support this motion, the State submits a declaration from Dr. Bruce Egan, one of the Nation's leading air dispersion experts. Dr. Egan has had a distinguished career in the private sector and academia and advises both private corporations and governments concerning air dispersion issues. The declaration reviews the principles of air dispersion modeling and the terrain in the vicinity of the Indian Point facilities, and explains why the ATMOS straight line Gaussian air dispersion model relied on by Entergy and NRC Staff is scientifically unreliable for Indian Point. Dr. Egan also references documents prepared by the federal government – including the Environmental Protection Agency, Department of Energy, and NRC itself – and scientific textbooks that support this conclusion. In short, there is no justification for the use of a straight line air dispersion model for this site.

## REGULATORY FRAMEWORK

In 1989, the U.S. Court of Appeals for the Third Circuit ruled that the National Environmental Policy Act (NEPA) required NRC to examine the environmental effects of significant accidents at nuclear power plants. *Limerick Ecology Action, Inc. v. U.S. Nuclear Regulatory Comm'n,* 869 F.2d 719, 729-31 (3d Cir.1989). Thereafter, NRC promulgated regulations for the conduct of significant accident mitigation alternative analyses (or "SAMA" analyses) during the Staff's review of an application to renew a power reactor's operating license. That regulation provides: "If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided." 10 C.F.R. § 51.53(c)(3)(ii)(L).[1] Because Indian Point Unit 2 and Unit 3 received their operating licenses in 1973 and 1975, they were not subject to a SAMA when they received permission to operate. *See* NUREG 1350, Information Digest (Vol. 20) at 103. Accordingly, NRC regulations required Staff to conduct a SAMA analysis during Staff's review of the application to renew the licenses for Indian Point's reactors.

[1] The Staff is obligated to evaluate the SAMA analysis and assure that it has been properly conducted pursuant to 10 C.F.R. Section 51.95(c)(4).

## PROCEDURAL AND FACTUAL BACKGROUND

In its Notice of Intent to Participate and Request for Hearing, the State of New York raised a contention challenging Entergy's use of the straight line Gaussian plume model in assessing the means to mitigate the impacts of a severe accident at Indian Point. *See* Notice of Intent to Participate and Request for Hearing, Contention 16, at 163-67 (Nov. 30, 2007). In Contention 16, the State alleged that:

> Entergy's Assertion in its SAMA Analysis for IP2 and IP3 That it "Conservatively" Estimated the Population Dose of Radiation in a Severe Accident Is Unsupported Because Entergy's Air Dispersion Model Will Not Accurately Predict the Geographic Dispersion of Radionuclides Released in a Severe Accident and Entergy's SAMA Will Not Present an Accurate Estimate of the Costs of Human Exposure.

In addition to meeting the detailed pleading requirements for contention admissibility, Contention 16 was supported by a detailed 21-page declaration of Dr. Bruce Egan who provided substantial technical support, including references to published technical and scientific reports that further elaborated upon the evidentiary basis for Contention 16. *See* New York State Notice of Intention to Participate and Petition to Intervene, Supporting Declarations and Exhibits (Nov. 30, 2007) Volume II. Dr. Egan's declaration provided substantial analysis of the issue and the evidence that supports the State of New York's claim that the ATMOS air dispersion model, used by Entergy in conducting the SAMA analysis, was wholly inappropriate for use at the Indian Point site.

Both Entergy and NRC Staff opposed admission of this contention. Entergy argued that it improperly challenged the NRC regulatory process, failed to raise an issue that is material to the outcome of the proceeding, and fails to establish a genuine dispute with the Applicant, and that the State sought to litigate the adequacy of the MACCS2 model used by Entergy to perform its SAMA Analyses and "*not* the adequacy of Entergy's LRA *per se*." *See* Answer Of Entergy Nuclear Operations, Inc. Opposing New York State Notice Of Intention To Participate and Petition to Intervene (Jan. 22, 2008), at 110 (emphasis in original). NRC Staff also argued that Contention 16 failed to raise a genuine material issue and is inadmissible. *See* NRC Staff's Response to Petitions for Leave to Intervene Filed by the State of New York *et al.*, (Jan. 22, 2008) at 56-58.

In ruling on the admissibility of Contention 16, the Board accepted the Contention:

> to the extent that it challenges whether the ATMOS module in MACCS2 is being used beyond its range of validity – beyond thirty-one miles (fifty kilometers) – and, whether use of MACCS2 with the ATMOS module leads to non-conservative geographical distribution of radioactive dose within a fifty-mile radius of IPEC.

LBP 08-13 at 78.

On February 27, 2009, following the release of the Staff's Draft Supplemental Environmental Impact Statement (Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38 Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment (NUREG-1437 (Supplement 38))("DSEIS")), the State submitted supplemental Contention 16A, which argued that the Staff's DSEIS improperly accepted Entergy's population dose estimates of radiation released in a severe accident despite the Licensing Board's admission of Contention 16, which argued that the air dispersion model Entergy used in its SAMA analysis will not accurately predict the geographic dispersion of released radionuclides and will result in an inaccurate estimate of the costs of human exposure. *See* State of New York Contentions Concerning NRC Staff's Draft Supplemental Environmental

Impact Statement (Feb. 27, 2008). The Board subsequently admitted Contention 16A because the DSEIS "fail[ed] to take into consideration the issues raised by New York in NYS-16 as admitted by the Board." Order (Ruling on New York State's New and Amended Contentions)(June 16, 2009) at 6-7 (footnote omitted).

In addition to filing Contentions 16 and 16A in the relicensing proceeding, the State had previously raised its concerns regarding the NRC Staff's modeling choices in comments submitted on the scoping and Draft Supplemental Environmental Impact Statements. *See* New York State Executive Agencies and the Department of Law Scoping Comments on the License Renewal of Indian Points Units 2 and 3, Buchanan, New York submitted to the United States Nuclear Regulatory Commission October 31, 2007 at 16 ("NYS Scoping Comments"). The State's comments focused on complexities of the Indian Point terrain and meteorology:

> Pursuant to NEPA, the NRC must examine up-to-date and facility-specific information regarding meteorological plume behavior. Entergy's model for atmospheric dispersion of a point release of radionuclides does not take into account variable meteorological conditions such as wind speed and direction changes, Hudson Valley topography, and coastal breezes. Such omissions are of critical concern, and this data must be fully analyzed. The scope of a NEPA review should include whether the plume model is sufficiently accurate for use in computing the health and safety consequences of an accident, as an environmental issue.

*See* NYS Scoping Comments at 16.

Thus, by the time it was preparing the DSEIS, NRC Staff was fully aware of the State's contention regarding the defects in the ATMOS model as applied to the Indian Point site, the bases for that contention, and substantial supporting evidence for those bases. Nevertheless, the DSEIS is silent on the issue of the inappropriateness of using ATMOS for air dispersion modeling in the SAMA analysis for Indian Point — in disregard of NRC's obligations under

NEPA, 10 C.F.R. § 51.53(c)(3)(ii)(L), and the Commission's mandate to Staff to consider possible plant upgrades to mitigate the impacts of severe accidents at nuclear power plants when preparing supplements to the 1996 Generic Environmental Impact Statement. *See* 61 Fed. Reg. 28467, 28480 (June 5, 1996) (Statement of Considerations); *see also* DSEIS, Volume 1 at 5-4 to 5-12 and Volume 2 at Appendix G.

In its purported critical review of Entergy's SAMA analysis, Staff devoted less than a page to a discussion of MACCS2 (the computer model that relies upon ATMOS)(DSEIS Vol. 2, Appendix G at G-17 to G-18) and none of that discussion even mentioned ATMOS or air dispersion modeling. The DSEIS contains not even a reference to the State's critical comments about ATMOS or Dr. Egan's declaration. Not only did the Staff not take a "hard look" at the methodology used to evaluate severe accident mitigation alternatives (*see Kleppe v. Sierra Club*, 427 U.S. 390, 410 n.21 (1976), *Limerick Ecology Action, Inc. v. U.S. Nuclear Regulatory Comm'n* 869 F.2d 719, 737 (3d Cir.1989)), it took *no* look at that issue. The DSEIS does not contain "sufficient discussion of the relevant issues and opposing viewpoints to enable the decisionmaker to take a 'hard look' at the environmental factors and to make a reasoned decision" *Limerick*, 869 F.2d at 737, quoting *Kleppe*, 427 U.S. at 410 n. 21.

In this case Entergy relied upon, and Staff accepted without any critical comment, the ATMOS air dispersion model, which is part of the standard MACCS2 model. The ATMOS model is a straight line Gaussian plume model. Statement of Material Facts Not in Dispute ("Statement of Facts"), ¶ 22; Egan Decl., ¶ 35. However, it does not have the capability to provide a reliable estimate of air dispersion if the release occurs in an area with complex terrain. Statement of Facts, ¶ 35; Egan Decl. ¶ 37. Complex terrain refers to sites like Indian Point, where there is a river valley, with steep banks and substantial mountains in close proximity to the Indian Point site. Egan Decl. ¶ 31-33. These and other features of the area around Indian Point make calculation of the dispersion of radiation following an accident complicated. Because the Gaussian plume model is a "straight line model," it is unsuited for, and incapable of, calculating impacts on air dispersion of these complicated terrain features. Egan Decl. ¶¶ 22, 37, 60.

The State's air dispersion expert, Dr. Egan, has had extensive experience with the use of both the Gaussian plume model and more sophisticated models. It is his considered opinion, provided in the attached affidavit and accompanying references, that the Gaussian plume model cannot provide a reliable estimate of the air dispersion of radiation released from the postulated severe accidents. That opinion is fully supported by the NRC Staff which recently made a presentation to the 2009 National Radiological Emergency Planning Conference in which it admitted that the Gaussian plume model was not suitable for use with complex terrain.[2] In addition, virtually all competent independent experts, including federal agencies that rely upon air dispersion modeling results to carry out their functions, acknowledge that the Gaussian plume model is unsuitable for measuring air dispersion at sites that have complex terrain. *See* Egan Decl., ¶¶ 48-57.

In the face of this universal rejection of the Gaussian plume model for use at sites like Indian Point, the State of New York submits that the Board can and should grant summary disposition on that aspect of Contentions 16 and 16A and should conclude that the Gaussian

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[2] *See* Stephen F. LaVie, Sr. Emergency Preparedness Specialist, United States Nuclear Regulatory Commission, Power Point Presentation: *What's in the Black Box Known as Emergency Dose Assessment?* Prepared for the 2009 National Radiological Emergency Planning Conference, Dose Assessment Workshop, Part 2, annexed to the Declaration of Dr. Bruce Egan (also available at ML091050257). Additional portions of NRC's power point presentation may be viewed at the following ADAMS accession numbers: ML091050226, ML091050269. NRC Staff did not disclose this power point file presentation as part of the discovery production in the license renewal

plume model relied upon by Staff in its DSEIS is an unreliable methodology for determining the dispersion of radiation from Indian Point in the event of the postulated severe accidents analyzed in the SAMA portion of the DSEIS.[3]

## APPLICABLE LEGAL STANDARDS

10 C.F.R. §§ 2.710 and 2.1205 provide standards for granting or denying a summary disposition motion. Pursuant to § 2.1205(c) the governing provisions are those contained in § 2.710. A recent decision in the *Diablo Canyon* Independent Spent Fuel Storage Installation (ISFSI) proceeding summarizes the legal standards applicable to a summary disposition motion:

> In NRC adjudicatory proceedings, summary disposition motions — which are the functional equivalent of summary judgment motions (*Advanced Medical Systems, Inc.* (One Factory Row, Geneva, Ohio), CLI-93-22, 38 NRC 98, 102 (1993)) — are addressed in 10 C.F.R. § 2.710, which states that summary disposition shall be granted if the "filings in the proceeding ... together with the statements of the parties and the affidavits ... show that there is no genuine issue as to any material fact and that the moving party is entitled to a decision as a matter of law" (10 C.F.R.§ 2.710(d)(2)).
>
> The moving party bears the initial burden of informing the tribunal of the basis for its motion and identifying those portions of the record that demonstrate the absence of a genuine issue of material

proceeding.

[3] The State of New York does not believe that the second part of Contention 16/16A, *i.e.,* whether the deficiency in the air dispersion model requires that Staff conduct a new SAMA analysis for Indian Point using an appropriate model, is ripe for resolution at this time. In *In re Entergy Nuclear Generation Company and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station) Docket No. 50-293-LR (CLI-09-11), the Commission described the ultimate issue this way: "whether any additional SAMA should have been identified as potentially cost beneficial, not whether further analysis may refine the details in the SAMA NEPA analysis." *Id.* at 7. To date, Staff has turned over little discovery on this issue and no proprietary documents have yet been produced that bear on that issue. The full MACCS2 code has not been produced; the State and Staff are still completing arrangements for the delivery of MACCS2 computer code to the State. Only when the full MACCS2 discovery is completed and analyzed by the State will the State be able to fully address the issue identified by the Commission in *Pilgrim* although there is already strong evidence that reliably predicting the plume movement can "potentially" have a substantial impact on the calculated population at risk and the total exposure. However, that analysis may present factual issues which must be resolved at the hearing. At this stage, the further conduct of this hearing will be greatly simplified if this underlying issue, *i.e.* whether the SAMA analysis used a reliable air dispersion methodology, is resolved.

> fact (*Celotex Corp. v. Catrett*, 477 U.S. 317, 323 (1986)). The nonmoving party cannot rest on the mere allegations or denials of a pleading, but must "go beyond the pleadings and by [the party's] own affidavits, or by the depositions, answers to interrogatories, and admissions on file, designate specific facts showing that there is a genuine issue for trial" (*id.* at 324) (internal quotation marks omitted). The tribunal must examine the evidence in the light most favorable to the nonmoving party (*Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 255 (1986)).

*In re Pacific Gas and Electric Company* (Diablo Canyon Power Plant Independent Spent Fuel Storage Installation) 67 N.R.C. 361, 371-372 (2008).

## ARGUMENT

### ATMOS PRODUCED UNRELIABLE AIR DISPERSION RESULTS FOR THE INDIAN POINT SAMA ANALYSIS

The attached Statement of Material Facts Not In Dispute identifies the fundamental facts that form the basis for this motion. Those facts, all of which come either from the Environmental Report, the DSEIS or incontrovertible air dispersion modeling experts and government agencies, demonstrate that:

1. Indian Point is surrounded by the largest concentration of population of any nuclear power plant in the country and the population is concentrated primarily in discrete areas south, southeast and southwest of the plant site. *See* Statement of Material Facts Not In Dispute ("Statement of Facts"), ¶¶ 2-5. This substantial population and the differences in the concentration of population within 50 miles of Indian Point are such that an accurate calculation of the dispersion of airborne radiation following a hypothetical severe accident could result in a substantially different human exposure profile than the one produced by MACCS2 and relied upon in the DSEIS. *See generally* Statement of Facts; *see also* Declaration of Dr. Bruce Egan, sworn to August 28, 2009 ("Egan Decl."), ¶¶ 19, 26, 60.

2. The terrain surrounding Indian Point is complex and creates unique variations in the movement of air in the vicinity of Indian Point and for as much as 50 miles beyond. Statement of Facts, ¶¶ 25-35. The complex terrain features in the vicinity of Indian Point, can result in channeling radiation from a hypothetical accident down the Hudson River and toward the largest and most concentrated population areas. *Id.*

3. NRC Staff, as well as independent experts, agree with Dr. Egan that a straight line Gaussian plume model like the ATMOS model used in MACCS2 cannot accurately model the impact of these complex terrain features to calculate the movement of the plume of radiation from a hypothetical severe accident at Indian Point. *See* Statement of Facts, ¶¶ 36-67; Egan Decl. ¶¶ 24, 28-30, 35-57. However, the DSEIS accepted the use of ATMOS as the air dispersion model for the MACCS2 code for purposes of the Indian Point SAMA analysis, without question and without consideration of any of the criticisms of that model raised by the State of New York and echoed in numerous NRC and other official statements by federal agencies and experts. Statement of Facts, ¶ 35; Draft Supplemental Environmental Impact Statement, Draft NUREG-1437, Supplement 38 (DSEIS).

4. Alternatives exist, of which NRC is aware, that could provide reliable air dispersion analysis for use in the Indian Point SAMA analysis. Statement of Facts, ¶¶ 44-50; Egan Decl., ¶¶ 29-30.

### A. The 50-Mile Area Around Indian Point Is Densely And Not Evenly Populated

The Indian Point Station is located in the northwest corner of Westchester County on the eastern bank of the Hudson River. Statement of Facts, ¶ 1; DSEIS at § 2.1, p. 2-1. It is approximately 24 miles north of the New York City line, and approximately 37 miles north of Wall Street, in lower Manhattan. Statement of Facts, ¶ 2; DSEIS at 2-1. The station is approximately three miles southwest of Peekskill, with a population of 22,441; five miles northeast of Haverstraw, with a population of 33,811; 16 miles southeast of Newburgh, with a population of 31,400; 17 miles northwest of White Plains, with a population of 52,802 and approximately 18 miles southwest of Brewster, New York. *Id.* It is also 23 miles northwest of Greenwich, Connecticut; 37 miles west of Bridgeport, Connecticut and 37-39 miles north northeast of Jersey City and Newark, New Jersey. *Id.* Portions of four counties - Westchester, Rockland, Orange, and Putnam - fall within the inner 10-mile Emergency Planning Zone, and significant population centers in New York, Connecticut, and New Jersey lie within the 50 mile

Emergency Planning Zone. *Id.* The U.S. Census Bureau estimated that New York City, located approximately 24 miles south of plant, had a population of 8,214,426 in 2006. Statement of Facts, ¶ 4; DSEIS at 2-1. The total estimated population within a 50 mile radius of the Indian Point Station is more than 17 million. Statement of Facts, ¶ 5; DSEIS at Table 2-1. Indian Point also has the highest surrounding population within 50 miles of any operating nuclear power plant in the Nation. Statement of Facts, ¶ 5; April 17, 1973 Atomic Energy Commission Report Population Distribution Around Nuclear Power Plant Sites, Appendix B, Figures 2 & 4, PDR Fiche No. 8111120800.

Because the population surrounding Indian Point is extremely large and because that population is not evenly distributed around the site, the direction of air dispersion from the site in the event of a severe accident can make a substantial difference in the number of people exposed and the total level of exposure. Statement of Facts, ¶ 18; Egan Decl. at ¶¶ 19, 26, 60. For this reason, it is extremely important that the air dispersion model used in the Indian Point SAMA analysis is accurate since the SAMA analysis must calculate the number of people exposed and the level of their exposure in order to ascertain the economic cost of the hypothetical severe accident and the consequent benefit of mitigating the accident with a particular safety improvement. DEIS at 5-4 to 5-5.

**B. The Terrain Surrounding The Indian Point Site is Complex And Significantly Impacts Air Dispersion**

The EPA defines complex terrain as any place where the area around the plant is higher than the top of the point from which the release will occur. 40 C.F.R. Part 51, Appendix W,

§ 4.1(b). It is conceded in the DSEIS that the highest point from which a release would occur at the plant is the stack which is less than 400 feet tall. DSEIS at page 2-2. Within two miles of the Indian Point site there are mountains and bluffs that range from 800 feet to over 1,000. *Id.*

Other features of the Indian Point site add to the complexity of the Indian Point terrain. First, it is located adjacent to a large river which has an important influence on air flow and dispersion of releases from the Indian Point site. Statement of Facts, ¶ 1; Egan Decl. at ¶¶ 30-33. Second, the river is in a valley with steep sides into which any plume would sink during the night time hours. Statement of Facts, ¶ 53; Egan Decl. ¶ 40.

These complex terrain features have a direct impact on air flow from the site which affect the rates of vertical and horizontal mixing of any pollutants released from the plant. Egan Decl. at ¶ 38. "The presence of high terrain distorts and changes the directions of approaching winds because the flow cannot pass through the terrain. The distortion of the flow direction materially changes the downwind destination of pollutants emitted into the airflow and, for elevated stack emissions, reduces the distance of plume material to the ground surface generally increasing the ground level concentrations." Statement of Facts, ¶ 24; Egan Decl. at ¶ 20. In addition "the presence of valley sidewalls together with radiational cooling will cause drainage flows that further distort air flow directions." Statement of Facts, ¶ 24; Egan Decl. at ¶ 21. One way to address these complexities is to input data from a number of meteorological stations in the immediate vicinity of the source, thus addressing the spatial variations of the wind. Egan Decl. at ¶ 23.

In order to reliably calculate air dispersion from a hypothetical severe accident at the Indian Point site it is essential that a computer model be able to take account of all these variable terrain conditions. Egan Decl. at ¶¶ at 25-27.

### C. It is Undisputed That Straight Line Gaussian Plume Models Are Not Reliable When Used In Complex Terrain

The core of this motion is the universally accepted fact that straight line Gaussian plume models cannot reliably model air dispersion where there are complex terrain features such as are present at Indian Point. *See* Egan Decl., ¶¶ 31-59. This fact is recognized by the NRC (Statement of Facts, ¶¶ 56-63, 66; Egan Decl. ¶¶ 43-46, 48, 51-55), and numerous other authorities (Statement of Facts, ¶¶ 64, 65, 68; Egan Decl. ¶¶ 54, 56-58, *inter alia*), even though, in the DSEIS for Indian Point, no effort was made to apply a different air dispersion model in the MACCS2 SAMA analysis or to justify the continued use of the inherently unreliable ATMOS model for this complex terrain site.

The NRC, in a 2009 Presentation to the National Radiological Emergency Planning Conference, ("NRC 2009 Presentation") concluded that straight-line Gaussian plume models cannot accurately predict dispersion in a complex terrain such as the Indian Point site and are therefore scientifically defective for that purpose. Egan Decl. ¶ 43-46; Exhibit 4 (Stephen F. LaVie, Senior Emergency Preparedness Specialist, United States Nuclear Regulatory Commission, Power Point Presentation: *What's in the Black Box Known as Emergency Dose Assessment?*, prepared for the 2009 National Radiological Emergency Planning Conference Dose Assessment Workshop, Part 2, Dispersion (ML091050257).

The NRC states that the "most limiting aspect" of the basic Gaussian Model, is its "inability to evaluate spatial and temporal differences in model inputs." NRC 2009 Presentation, Slide 28. Because ATMOS is non-spatial, it cannot account for the effect of terrain on the trajectory of the plume - that is, the plume is assumed to travel in a straight line regardless of the surrounding terrain. Therefore, it cannot, for example, "'curve' a plume around mountains or follow a river valley." *Id.*, Slide 33. The NRC 2009 Presentation also acknowledges the "gravity sink" phenomenon that could cause the plume to travel down river towards New York City from a valley site such as Indian Point. Egan Decl. ¶ 45. As Slide 46 explains, the air in a valley is not heated directly by the sun but by heat convection from the earth. NRC 2009 Presentation, Slide 46. At night the earth cools and because higher elevations cool faster, cool air flows toward warmer air in the valley. This flow is described by the NRC as "gravity drainage," and in the absence of other meteorological influences, (such as high wind speeds) the drainage will tend to flow down river. *Id.*[4]

This concession by NRC that a model like ATMOS is unsuitable for the complex terrain at Indian Point conclusively demonstrates that summary disposition should be granted in the State's favor since an admission by a party is admissible evidence against that party. *See* Rule 801(d)(2) of the Fed. R. of Evid. However, there is much more evidence of the widespread recognition of the inappropriateness of using a model like ATMOS for air dispersion modeling at complex terrain sites like Indian Point.

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[4] It was the discovery of this presentation that provided the State with the confirmation that NRC Staff had, except for purposes of the DSEIS for this site, accepted the fact that ATMOS was inappropriate for use with complex terrain such as is found at Indian Point. Staff did not produce any of the NRC documents cited in Dr. Egan's affidavit or relied upon in this pleading that relate to air dispersion modeling as part of their disclosures under 10 C.F.R. § 2.336(b). Should Staff take the position that air dispersion modeling was not part of the license renewal application review process, it should be noted that this admission underscores the disconnect between the reviewing process and the actual technical expertise within the Staff. However, Staff devoted some time to considering the merits of Contention 16/16A and thus should have had to explore the technical basis for the contention (NRC Staff's Response to Petitions for Leave to Intervene Filed by the State of New York *et al.*, (Jan.. 22, 2008) at 56-58), and it is therefore curious that Staff did not produce the document.

As early as 1977 NRC began to recognize that complex terrain presents special problems that a model must address if the air dispersion analysis is to be accurate. *See* Egan Decl. ¶ 51; Exhibit 6, United States Nuclear Regulatory Commission Office of Standard Development, Regulatory Guide 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors* (July 1977) (Draft for Comment). ("Geographic features such as hills, valleys, and large bodies of water *greatly* influence dispersion and airflow patterns. Surface roughness, including vegetative cover, affects the degree of turbulent mixing." (emphasis added)). However, as the draft Regulatory Guide acknowledges, Gaussian plume models that, like ATMOS, rely on a constant mean wind direction are unable to deal with geographic features. "Effects of spatial and temporal variations in airflow in the region of the site are not described by the constant mean wind direction model. Unlike the variable trajectory models, the constant mean wind direction model can only use meteorological data from a single station to represent diffusion conditions within the region of interest." *Id.* at 1.111-9. Finally, the draft Regulatory Guide proposed a regulatory policy, which if implemented in this case, would have rejected the use of the ATMOS model for the SAMA analysis. "The preferred model is that which best simulates atmospheric transport and diffusion in the region of interest from source to the receptor location, considering the meteorological characteristics of the region, the topography, the characteristics of the effluent source and the effluent as well as the receptor, the availability and representativeness of input data, the distance from source to receptor, and the ease of application." *Id.* at 1.111-7.

Since 1977 there has been a growing consensus among air dispersion experts and federal agencies, including NRC, that straight line Gaussian plume models are unacceptable for use with complex terrain. Statement of Facts, ¶¶ 36-67; Egan Decl. ¶¶ 51-59. For over three decades atmospheric scientists and meteorologists have been identifying problems in the use of models similar to ATMOS for such settings. Statement of Facts, ¶ 35; Egan Decl. ¶ 59 (*see also* Egan Decl., Exhibit 11 (Steven R. Hanna, Gary A. Briggs, Rayford P. Hosker, Jr., National Oceanic and Atmospheric Administration, Atmospheric Turbulence and Diffusion Laboratory, *Handbook on Atmospheric Diffusion* (1982)). In March 1996, the NRC issued RTM-96, Response Technical Manual, which contains "simple methods for estimating the possible consequences of different kinds of radiological accidents." Egan Decl. ¶ 54; Ex. 7 (T. McKenna, J. Trefethen, K. Gant (ORNL), J. Jolicoeur, G. Kuzo, G. Athey, United States Nuclear Regulatory Commission, Incident Response Division, Office for Analysis and Evaluation of Operational Data, RTM-96: Response Technical Manual (NUREG/BR-0150, Vol. 1, Rev. 4) (Mar. 1996). In the glossary of that document, the NRC's definition of "Gaussian plume dispersion model" states that such models have important limitations, including the inability to "deal well with complex terrain." *Id.*

In June 2004, the U.S. Department of Energy's Office of Environment, Safety and Health issued a final report entitled MACCS2 Computer Code, Application Guidance for Documented Safety Analysis. United States Department of Energy Office of Environment, Safety and Health, *MACCS2 Computer Code Application Guidance for Documented Safety Analysis: Final Report* (June 2004)("MACCS2 Guidance")(annexed to the Egan Declaration as Exhibit 10). Statement of Facts, ¶ 65; Egan Decl., ¶ 57. In Table 2-1, Summary Description of MACCS2 Code Software, under the heading Restrictions or Limitations, the Guidance also states "the atmospheric model included in the Code does not model the impact of terrain effects on atmospheric dispersion nor can it accept more than one weather spatial location." Statement of Facts, ¶ 65; Egan Decl., ¶ 57; MACCS2 Guidance at 2-5. Table 6-1, entitled "Limitations of Gaussian Plume Model in MACCS2 and MACCS," describes the "terrain sensitivity" of the Gaussian plume model as "flat earth" to "gently rolling" and instructs that "complicated terrain over the region of transport may require Lagrangian particle or other models." Statement of Facts, ¶ 65; Egan Decl., ¶ 57; MACCS2 Guidance at Table 6-1.

In 2005 DOE reemphasized the problem with using the ATMOS simple straight line Gaussian plume model in the MACCS2 Code when complex terrain is involved. The Radiation Safety Information Computational Center ("RSICC") of the Department of Energy's Oak Ridge National Laboratory has a summary description of the MACCS2 Code in its Code Package CCC-652. *See* RSICC Code Package CCC-652, *MACCS2 Ver. 1.13.1: MELCOR Accident Consequence Code System for the Calculation of the Health and Economic Consequences of Accidental Atmospheric Radiological Releases* (Abstract dated May 1997, revised June 1998, March 2004, June 2005)(annexed to the Egan Declaration as Exhibit 9). Under the heading "Restrictions or Limitations," the RSICC unequivocally states that "the atmospheric model included in the code does not model the impact of terrain effects on atmospheric dispersion." *Id.* (emphasis added). Thus, in relying on ATMOS to model air dispersion in the complex terrain setting of the Indian Point site as part of the MACCS2 calculations for the SAMA analysis, the DSEIS was violating guidelines for MACCS2 use issued by the agency under whose guidance MACCS2 was developed.

In December 2005, as part of a cooperative program between the governments of United States and Russia to improve the safety of nuclear power plants designed and built by the former

Soviet Union, the NRC issued Procedure Guides for a Probabilistic Risk Assessment related to a Russian Nuclear Power Station. Statement of Facts, ¶ 63; Egan Decl., ¶ 55; United States Nuclear Regulatory Commission/Brookhaven National Laboratory, NUREG/CR-6572, Rev. 1, Kalinin VVER-1000 Nuclear Power Station Unit 1 PRA: Procedure Guides for a Probabilistic Risk Assessment (Dec. 2005) (ML060450618)("Kalinin Procedure Guides")(excerpts of which are annexed to the Egan Declaration as Exhibit 8). The Guides, prepared by the Brookhaven National Laboratory and NRC staff, explained that atmospheric transport of released material is carried out assuming Gaussian plume dispersion, which is "generally valid for flat terrain." Statement of Facts, ¶ 63; Egan Decl. ¶ 55; Kalinin Procedure Guides at 3-114. However, the Guides contained the caveat that in "specific cases of plant location, such as, for example, a mountainous area or a valley, more detailed dispersion models may have to be considered." Statement of Facts, ¶ 63; Egan Decl., ¶ 5; Procedure Guides at 3-114. When giving assistance to Russia, NRC warned of the unreliability of using ATMOS for complex terrain settings, but ignored its own advice in preparing the DSEIS for Indian Point.

Most recently, the NRC revised their Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants. *See* United States Regulatory Commission, Regulatory Guide 1.23, Meteorological Monitoring Plan for Nuclear Power Plants (Rev. 1, Mar. 2007) (annexed to the Egan Declaration as Exhibit 13). This Guide recognizes the important relationship between meteorological measurements and atmospheric dispersion modeling in the Introduction on page 3: "Thus, each nuclear power plant has multiple needs for an onsite program to measure and document basic meteorological information. These data may be used to develop atmospheric transport and diffusion parameters that with appropriate (emphasis added) atmospheric dispersion models, may be used to estimate potential radiation doses to the public resulting from actual routine or accidental releases of radioactive materials to the atmosphere or to evaluate the potential dose to the public and control room as a result of hypothetical reactor accidents....This regulatory guide describes a suitable onsite program to provide meteorological data to estimate these impacts."

Regulatory Guide 1.23 also indicates that a meteorological program should be capable of providing the information needed to make several assessments including: "a realistic assessment by both the applicant and the regulatory staff of the potential dispersion of radioactive materials from, and the radiological consequences of, a spectrum of accidents to aid in evaluating the environmental risk posed by a nuclear power plant in accordance with Subpart A to 10 CFR Part 51." *Id.* at 5. On page 11, the section entitled "Special Considerations for Complex Terrain Sites" states that the program "should provide an adequate basis for atmospheric transport and diffusion estimates ... [within 8 kilometers (5 miles) in each downwind sector]" (brackets in original) and mentions special "complex flow patterns in nonuniform terrain" and "circulation for a hill-valley complex or a site near a large body of water." Regulatory Guide 1.23, Ex. 13, at 11. The Regulatory Guide also states that "[t]he plant's operational meteorological monitoring program should provide an adequate basis for atmospheric transport estimates [emphasis added] within the plume exposure emergency planning zone [i.e., within approximately 16 kilometers (10 miles)]." Regulatory Guide 1.23, at 11. Thus, Regulatory Guide 1.23 illustrates that the NRC recognizes there are certain sites, such as Indian Point, where multiple meteorological data input sources are needed for appropriate air dispersion modeling. Since, for the reasons discussed in this pleading, ATMOS is incapable of handling complex flow patterns and meteorological data input from multiple locations, Regulatory Guide 1.23 is an NRC admission that ATMOS should not be used at a complex terrain site like Indian Point.

Even basic textbooks for college-level introductory courses in environmental science and engineering, in listing the assumptions that are made to develop a simple straight line Gaussian plume model, warn:

> The equation is to be used over relatively flat, homogeneous terrain. It should not be used routinely in coastal or mountainous areas, in any area where building profiles are highly irregular, or where the plume travels over warm bare soil and then over colder snow or ice-covered surfaces.

Environmental Science and Engineering, J. Glynn Henry & Gary W. Heinke, (Prentice-Hall 1989) at 528 (Egan Decl., Ex. 12); *accord* Radiological Risk Assessment and Environmental Analysis: John E. Till, Helen A. Grogan (Oxford University Press 2008) at 118-19.

Significantly, the Environmental Protection Agency (EPA) replaced its recommendation to use a straight line Gaussian plume model for air dispersion (the ISC3ST Model) with a newer model that incorporates features that can address complex terrain (AERMOD). Statement of Facts, ¶ 41; Egan Decl., ¶ 28; 70 Fed. Reg. 68,218 (Nov. 9, 2005). As Dr. Egan points out in his Declaration at paragraph 28, this change was made only after extensive testing confirmed the advantage of using AERMOD in providing more accurate results where complex terrain exists. EPA explained it this way:

> Finally, the adequacy of AERMOD's complex terrain approach for regulatory applications is seen most directly in its performance. AERMOD's complex terrain component has been evaluated extensively by comparing model-estimated regulatory design values and concentration frequency distributions with observations. These comparisons have demonstrated AERMOD's superiority to ISC3ST and CTDMPLUS (Complex Terrain Dispersion Model PLUS unstable algorithms) in estimating those

flat and complex terrain impacts of greatest regulatory importance.

*Id.* 70 Fed. Reg. at 68,220. These tests, conducted in complex terrain settings, showed the "superiority" of the more modern approach adopted by EPA and urged here by Dr. Egan, over the antiquated and unreliable straight line Gaussian plume model, for complex terrain like that found at Indian Point.[5]

These terrain-relevant tests should be compared to the unrepresentative terrain setting used by Lawrence Livermore in its study in 2002. Statement of Facts, ¶ 56; Egan Decl., ¶¶ 48-50; United States Nuclear Regulatory Commission/Lawrence Livermore National Laboratory, NUREG/CR-6853, *Comparison of Average, Transport and Dispersion, Among a Gaussian, a Two-Dimensional, and a Three-Dimensional Model* (Oct. 2004) (ML043240034)("Livermore Study")(annexed to the Egan Declaration as Exhibit 5). In that study, Lawrence Livermore compared ATMOS to several more sophisticated air dispersion models in a setting without complex terrain. Egan Decl., ¶ 48; Livermore Study. The Livermore Study, when properly analyzed, provides support for the proposition urged here by the State of New York. First, the study was in terrain that is unlike the terrain present at Indian Point. Second, the study compared annual average numbers, a value of little if any relevance to determining what will be the short-term exposure of the population within 50 miles of Indian Point in the event of a severe accident

[5] The EPA includes an extended discussion of the inherent uncertainty associated with all air dispersion models, noting at one point that missing the actual wind direction by as little as 5-10% could produce a difference in the predicted ground level concentration of the pollutant of concern by as much as 20-70% for a particular time and place. 70 Fed.Reg. at 68,246. Although beyond the scope of a permissible contention because it challenges an NRC Regulation, it is significant to note that the SAMA analysis, presented in the ER and approved in the DSEIS, treats the end results of the MACCS2 calculations as fairly precise numbers and mitigation measures that miss being cost effective by even a few thousand dollars are rejected. It would appear that the inherent uncertainty in measuring the actual exposures that could occur in the event of a severe accident at Indian Point would result in a far more conservative approach to the cost/benefit analysis than now exists in the regulations. Of course the effect of the inherent uncertainty is made substantially worse by Staff's insistence, in this case, that it will rely on an air dispersion model that has been shown to be substantially less reliable than more advanced models for complex

the fallout from which is likely to last for, at most, a few days. Third, the authors of the study went out of their way to emphasize that "[i]n regions with complex terrain, particularly if the surface wind direction changes with height, caution should be used" (Livermore Study at 72)), thus recognizing what the EPA terrain-relevant studies confirm - *i.e,.* complex terrain makes a significant difference in air dispersion modeling and models that cannot accommodate such terrain variations are unreliable predictors of air dispersion from a discrete event at complex terrain sites. Egan Decl. ¶ 50. For these reasons, the Livermore Study does not justify Staff's continued use of ATMOS at Indian Point, and in fact, supports the State's motion.

The inherent limitations in the Gaussian plume straight line air dispersion model have even formed the basis for rejection of expert opinion in federal courts applying the principles of *Daubert v. Merrell-Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993). *See e.g. In re Voluntary Purchasing Groups, Inc. Litigation*, 2000 WL 1842779 (N.D.Tex. 2000) at *5 ("Plaintiffs have not established, however, that the ISCST3 model [a straight line Gaussian plume model] is even minimally reliable for modeling atmospheric dispersion of particulate matter over a long term, and long past, period of time. Dr. Baynes' own assertions in this regard are not sufficient. Plaintiffs have provided no evidence that this use of the ISCST3 model has been peer reviewed, tested, or generally accepted in the relevant scientific community." (footnote omitted)).

**D. There Are Models That Can Reliably Predict Air Dispersion at a Complex Terrain Site Like Indian Point**

A number of options exist that would reliably model air dispersion from Indian Point including models discussed in the attached Egan Declaration (¶¶ 24, 28-30) and in the 2009 Presentation by the NRC at Slides 35 and 36(Egan Decl., Ex. 4). The DSEIS makes no effort to

terrains and that is particularly unreliable with wind direction predictions.

address, or even acknowledge, these modeling options.

Puff type models simulate steady emissions rates as a series of separate "puffs" released over a time period so that the total quantity of the emissions is the same as if the release were steady. The individual puffs are then advected horizontally and diffuse across the modeling domain with the wind field. The concentration dosage received at any specific location is calculated by the sum of the exposures to each of the individual puffs. If a terrain feature causes the wind to turn, then the puffs will follow that change in wind direction, and the model will thereby provide a much more realistic simulation of the actual trajectories of the contamination. Egan Decl. ¶¶ 46-47. At least two readily available computer models could have been used in the SAMA analysis that would have reliably predicted air dispersion in the complex terrain of the Indian Point area. Statement of Facts, ¶¶ 41-50; Egan Decl. ¶¶ 28-30. While admittedly these models were not available 30 years ago when experts recognized the limitations of straight line Gaussian plume models and perhaps used them in lieu of preferable alternatives, no such excuse exists today as the following discussion demonstrates.

AERMOD was developed after more than a decade of efforts of many researchers to incorporate the greatly advanced understanding of boundary layer meteorology into the dispersion algorithms that were available when the Gaussian plume model was parameterized by Pasquill and Gifford. Statement of Facts, ¶ 46; Egan Decl. ¶ 29; *see also* Declaration of Dr. Bruce Egan in Support of the State of New York's Petition to Intervene (Nov. 27, 2007)(Egan Decl., Ex. 2), at ¶¶ 22 - 26 (discussing boundary layer meteorology).

Further, the AERMOD model was subjected to extensive statistical model evaluations in a variety of terrain settings. Statement of Facts, ¶ 47; Egan Decl. ¶ 29; 70 Fed.Reg. at 68,220.

These efforts showed that AERMOD represented a major improvement over the ISC3 and other models. *Id.*

The CALPUFF model is appropriate for simulating transport and dispersion in wind fields that change with space and time. Egan Decl. ¶ 30. It is often coupled to CALMET, a model that computes the needed wind and dispersion fields from meteorological data. *Id.* CALPUFF may also be coupled to a full mesoscale meteorological flow model such as MM5. *Id.* CALPUFF also has benefited from advances in the parameterization of wind fields and turbulent dispersion over the past four decades. *Id.* CALPUFF is routinely used in both simple and complex terrain settings to estimate ambient air concentrations at distances beyond the recommended 50 kilometer upper limit of AERMOD. *Id.* The air flow fields used by CALPUFF generally use data from more than one meteorological station in order to estimate concentrations at large distances from a source. Straight line Gaussian plume models, like ATMOS, to not have the capability to simultaneously use meteorological data from several different sources. *Id.*

The State of New York is not obligated and does not intend to select one of these models as the preferred choice. That obligation is with the Staff which, pursuant to NEPA, NRC Regulations and the Statement of Considerations, is obligated to conduct a reliable analysis of severe accident mitigation alternatives. What is clear is that Staff cannot do such an analysis for Indian Point by relying on the outdated and unreliable ATMOS model which cannot accommodate the complex terrain conditions at Indian Point which dominate the air flow patterns in this area.

## CONCLUSION

As the foregoing discussion demonstrates, the critical facts upon which this motion is based have been conceded or are beyond dispute. Indian Point presents a complex terrain which requires a sophisticated air dispersion model to reliably predict the airborne consequences of a hypothetical severe accident. Because of the enormous population at risk from the Indian Point plant, reliably predicting how many people will be exposed in the event of a severe accident is of critical importance, particularly for doing the SAMA analysis where decisions are to be reached on which safety improvements, if any, should be used to reduce population exposures. The DSEIS accepts ATMOS for air dispersion modeling even though ATMOS is inherently incapable of reliably modeling radiation releases from Indian Point. NRC knows this and has done nothing about it. Thus, for the reasons stated in this pleading and the accompanying Affidavit of Dr. Egan and the attached material, the State of New York urges the Board to grant summary disposition on the issue of whether ATMOS is a reliable air dispersion model for use in the MACCS2 SAMA analysis for Indian Point.

Respectfully submitted,

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## Consultation with Parties Pursuant to 10 C.F.R. § 2.323

On Tuesday, August 11, 2009, Assistant Attorney John Sipos held telephone conversations with Entergy's counsel Paul Bessette and subsequently with NRC Staff counsel Sherwin Turk and Entergy's counsel Katherine Sutton, Martin O'Neill, and Mr. Bessette. During those conversations Mr. Sipos informed opposing counsel that the State had located a document with an ADAMS accession number of ML091050257 that appeared relevant to NYC Contention 16/16A and planned to prepare a motion for summary disposition on that contention. (At this time, counsel also discussed the State's scheduling proposal for such motion and the State's plan to file a motion to expand the time in which the State could file a summary disposition motion.)

Counsel for Entergy and NRC Staff indicated that they did not contest the State's ability to file such a summary disposition motion and would reserve the right to respond to the substance of the motion once it was filed.

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