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Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: 2010 01 12 NYS Comments GEIS.pdf

Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of:

10 C.F.R. Part 51, Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses

NRC Docket ID
NRC-2008-0608
RIN 3150-AI42

COMMENTS SUBMITTED BY THE OFFICE OF THE ATTORNEY GENERAL OF THE STATE OF NEW YORK

Submitted: January 12, 2010

Office of the Attorney General
of the State of New York
120 Broadway, 26th Floor
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Exhibits

A - *Hydrogeologic Site Investigation Report* (GZA GeoEnvironmental, Inc., Jan. 7, 2008), Figures 6.9, 6.13, 6.14, and 9.1 - 9.4

B - Declaration of Bruce A. Egan, executed November 27, 2007

C - Declaration of Bruce A. Egan, executed August 28, 2009

D - Declaration of Raymond C. Williams, executed November 27, 2007

E - *Potential Impacts of Indian Point Relicensing on Property Values*, Stephen C. Sheppard, Ph.D. (2007)

F - Excerpt, Declaration by Dr. Richard T. Lahey, Jr., executed November 30, 2007

G - Declaration of Lynn R. Sykes, Ph.D., executed November 29, 2007, and Statement

H - Declaration of Leonardo Seeber, executed November 29, 2007, and Report

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of: 10 C.F.R. Part 51, Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses	NRC Docket ID NRC-2008-0608 RIN 3150-AI42

COMMENTS SUBMITTED BY THE OFFICE OF THE ATTORNEY GENERAL OF THE STATE OF NEW YORK

The People of the State of New York by its Attorney General submit these comments regarding the Nuclear Regulatory Commission's ("NRC") proposed Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses (the "Proposed Rule") and the revised Generic Environmental Impact Statement for License Renewal of Nuclear Plants (the "Proposed GEIS").

I. The State of New York's Interest in this Rulemaking Proceeding

The Proposed Rule and the Proposed GEIS affect the State of New York's residents, natural resources, and economy. These proposals concern the extended operation of nuclear power facilities, including the Indian Point facilities, and in many instances seek to limit the ability of the State and its citizens to participate in a thorough and transparent review of the environmental impacts that could flow from the continued operation of those facilities. The State submits these comments to ensure that the NRC officials squarely confront such impacts and examine the alternatives to the proposed agency action in a transparent manner.

Given the significant adverse consequences that could flow from a radiation release from a nuclear power plant, the State of New York has a strong interest in ensuring the safety of the Indian Point facilities and other nuclear plants within its borders; in protecting the State's natural resources from contamination; and in ensuring that the NRC undertakes a comprehensive and open analysis of all potential environmental impacts associated with the continued operation of those facilities.

As the NRC is aware, the State of New York, represented by Attorney General Andrew M. Cuomo, has opposed the relicensing of the Indian Point nuclear plants. The State has identified serious concerns about the safety and environmental impacts of Indian Point Units 1, 2, and 3, and has set these concerns out in the State's Petition to Intervene in the United State Nuclear Regulatory Commission's proceeding to consider whether to renew the operating licenses for these plants. On July 31, 2008, the Atomic Safety and Licensing Board issued a decision admitting 11 contentions presented by the State for an evidentiary hearing. *See In the Matter of Entergy Nuclear Operations, Inc.*, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (July 31, 2008). The ASLB subsequently admitted 4 additional contentions presented by the State. *See In the Matter of Entergy Nuclear Operations, Inc.*, ASLBP No. 07-858-03-LR-BD01, Order (June 16, 2009). The admitted contentions involve, among other things: weaknesses in the units' aging piping systems, electrical systems, and reactor pressure vessel; unauthorized radionuclide leaks from various components; and deficiencies in the significant accident mitigation analyses.

During the Indian Point relicensing process, NRC Staff have sought to preclude the State from raising site-specific issues which impact the communities surrounding the facilities including environmental impacts from: the use of spent fuel pools that continue to leak radionuclides into the State's environment and waters; loss of coolant in spent fuel pools and the uncovery, heat up, and fire of densely-packed spent fuel assemblies; land use devaluation from long-term on-site storage of high-level nuclear waste given the winding down of the Yucca Mountain project; malevolent acts or sabotage; and the proper model for accurate designation of the Emergency Planning Zone ("EPZ") and the development and implementation of a realistic and workable Emergency Evacuation Plan. According to Staff, such issues need not be examined because the NRC considered them to be "out of scope" or "generic" when NRC prepared the initial GEIS back in 1996 and then incorporated its findings into the Part 51 regulations. NRC relies on the classification of issues as Category 1 (generic) or Category 2 (site-specific) to define the kinds of information that will be available to the public regarding those issues, and the public's ability to be involved in governmental decisionmaking regarding nuclear power plants in New York. The State has significant concerns about Staff's continued reliance on the thirteen-year-old categorizations and proposal to continue such improper classifications in the Proposed GEIS and Proposed Rule.

II. Overview of Indian Point

According to Atomic Energy Commission ("AEC") and NRC documents, the Consolidated Edison Company ("ConEd") received the following construction permits and operation licenses on the following dates: [1]

	CONSTRUCTION PERMIT ISSUED	OPERATING LICENSE ISSUED
IP Unit 1	May 4, 1956	March 26, 1962
IP Unit 2	October 14, 1966	September 28, 1973
IP Unit 3	August 13, 1969	December 12, 1975

I
When ConEd selected the Indian Point site back in March 1955 and filed an application for the necessary construction permit, the AEC did not have site selection regulations that addressed population or seismic issues.

Of all the power reactors in the United States, the Indian Point reactors have the highest surrounding population both within a 50-mile radius and a 10-mile radius. *See, e.g.*, AEC, Population Distribution Around Nuclear Power Plant Sites, Figure 2: Typical Site Population Distribution (5-50 Miles) (April 17, 1973); Federal Emergency Management Agency, Nuclear Facilities & Population Density Within 10 Miles (June 2005). Today, more than 17 million people live within 50 miles of Indian Point reactors and spent fuel pools. No other operating reactor site in the country comes close to Indian Point in terms of surrounding population. Under NRC's current siting regulations, which were not in place when AEC approved the Indian Point site in 1956, it is highly unlikely that the Indian Point reactors could be located today in this densely populated area. *See* 10 C.F.R. § 100.21(h).

Although the 40-year Operating Licenses for Unit 2 and Unit 3 will expire in 2013 and 2015 respectively, various systems, structures, and components have already been place for 40 or more years. Indian Point Unit 2 and Unit 3 rely on various Unit 1 systems, structures, and components. Thus, given the regulatory history shown in the above chart, some of the basic systems, structures, and components already have been in place at the site for 40 to 53 years.

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[1]*See* 21 Fed. Reg. 3,085 (May 9, 1956); 31 Fed. Reg. 13,616-17 (Oct. 21, 1966); 34 Fed. Reg. 13,437 (Aug. 20, 1969); NUREG-1350, Volume 20, *2008 - 2009 Information Digest*, at 103, 113 (Aug. 2008). With respect to IP3, ConEd began construction and concrete pouring operations before the AEC issued the construction permit. *See, e.g.*, Letter, dated Nov. 15, 1968, from Harold Price, Director of Regulation, United States Atomic Energy Commission letter, to Consolidated Edison Company of New York, Inc., Docket No. 50-286 (authorizing the company to "proceed at your own risk, prior to issuance of a construction permit" with the pouring of concrete liner plates, walls of vessel cavity, recirculation pump pit, installation of bottom liner pit and rebar for the base for IP3).

Indian Point Unit 1's systems, structures, and components were not designed to meet current seismic construction standards and response spectra, which NRC would apply if an applicant sought to construct another reactor at the site. *See* 10 C.F.R. Pt. 100, Appendix A (before 1997); *see also* 10 C.F.R. § 100.21(c), (d)(after January 1997). From a seismic perspective, Unit 1 is even weaker than Unit 2 and Unit 3. Indeed, no seismic response spectra were generated for the Unit 1 site during its original design.

III. Overview and Overarching Issues

Published for comment on July 31, 2009, this proposed rule proposes to update the Commission's 1996 findings on the environmental impacts related to the renewal of a nuclear power plant's operating license, both in Title 10, Part 51 of the Code of Federal Regulations and in a revision of the 1996 GEIS for License Renewal of Nuclear Plants (the "1996 GEIS").

A. Statutory and Regulatory Background

The National Environmental Policy Act ("NEPA") requires every federal agency to examine the environmental impacts of its decisions and to inform the public that it has considered environmental concerns in its decision-making. *See, e.g., Marsh v. Or. Natural Res. Council*, 490 U.S. 360 (1989). NEPA requires federal agencies to prepare an environmental impact statement for all major federal actions significantly affecting the environment. 42 U.S.C. § 4332(2)(C).

The President's Council on Environmental Quality ("CEQ") has promulgated regulations implementing NEPA. 40 C.F.R. § 1500.1 *et seq*. NRC has recognized that the CEQ regulations are entitled to deference. 10 C.F.R. § 51.10; 43 Fed. Reg. 55,978-56,007 (Nov. 29, 1978). Those regulations provide that the environmental impacts examined by an EIS must include "[i]ndirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." *Id.* § 1508.8(b). "Reasonably foreseeable" effects include "impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason." *Id.* § 1502.22(b)(4).

As NRC itself has recognized, the decision to extend the operating term of a nuclear power plant is a major federal action that entails significant environmental impacts, and NEPA requires the discussion of such impacts in an Environmental Impact Statement. 10 C.F.R. § 51.20(a),(b)(2); *id.* at § 51.95(c).[1] These

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[1] *See also* 61 Fed. Reg. at 28483 (1996 SOC recognized that renewal of an operating

environmental impacts are widespread and involve, as is the case with Indian Point, substantial impacts on local water resources (both surface and ground), aquatic species, land use, and air quality, as well as the potentially devastating impacts on people and property in the event of a design basis accident or a severe accident.

A central feature of the environmental impact statement is the consideration of alternatives. 42 U.S.C. § 4332(2)(c)(ii); *Calvert Cliffs' Coordinating Committee, Inc. v U.S. Atomic Energy Comm.*, 449 F.2d 1109 1128-1129 (D.C. Cir. 1971). While NEPA does not itself require the federal agency to choose the alternative which, on balance, produces the least environmental impact while achieving the purpose of the proposed action, it does, when coupled with the provisions of the Administrative Procedure Act ("APA"), require that the federal agency provide a "rational basis" for its final decision. *See, e.g., Citizens Awareness Network v. United States Nuclear Regulatory Comm'n*, 59 F.3d 284, 293 (1st Cir. 1995). A significant portion of its "rational basis" must include, under NEPA, a "hard look" at the proposed action and alternatives to it. *Marsh*, 490 U.S. at 374 (1989). The federal agency must compile a record that demonstrates it considered all the relevant evidence before it and provided a rational explanation for why it accepted some evidence, rejected other evidence and in the end rejected or accepted the proposed action and the alternatives.

The regulations also provide that, after an agency prepares a draft EIS, it must solicit comments from, among others, state environmental agencies and the public. *Id.* § 1503.1. A final EIS must respond to those comments. *Id.* § 1502.9(b).

CEQ regulations and NEPA case law recognize that over time new information may become available that should be factored into the decision-making process or used to update a previous EIS. Agencies must supplement a previously issued EIS when "[t]here are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." 40 C.F.R. § 1502.9(c); *see also Marsh*, 490 U.S. at 374.

B. NRC Should Amend Its Existing and Proposed Regulatory System to Offer a Meaningful Mechanism to Consider New and Significant Information and Site-Specific Analysis of Environmental Impacts

When the Commission adopted what is now the Generic Environmental Impact Statement NUREG-1437 ("1996 GEIS") for license renewal applications it declared:

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license is a major plant licensing action); Proposed GEIS at S-1.

> The results should be a more focused and therefore a more effective NEPA review for each license renewal. The amendment will also provide the NRC with the *flexibility to address unreviewed impacts at the site-specific stage of review and allow full consideration of the environmental impacts of license renewal.*

61 Fed. Reg. 28,467 (June 5, 1996)(emphasis added). NRC also promulgated regulations that incorporated the conclusions contained in the GEIS and made them binding for all applications to renew operating licenses. Various commenters including the President's Council on Environmental Quality and the State of New York expressed concern that this regulatory approach would make NRC's 1996 GEIS conclusions forever immutable. In response, NRC committed that:

> The NRC will also review and consider any new and significant information presented during the review of individual license renewal applications.

Id. at 28,468. The Commission also created the following framework to address the concerns about the over-rigidity in the GEIS findings:

a. NRC's response to a comment regarding the applicability of the analysis of an impact codified in the rule to the plant in question may be a statement and explanation of its view that the analysis is adequate including, if applicable, consideration of the significance of new information. A commenter dissatisfied with such a response may file a petition for rulemaking under 10 CFR 2.802. If the commenter is successful in persuading the Commission that the new information does indicate that the analysis of an impact codified in the rule is incorrect in significant respects (either in general or with respect to the particular plant), a rulemaking proceeding will be initiated.

b. If a commenter provides new information which is relevant to the plant and is also relevant to other plants (i.e., generic information) and that information demonstrates that the analysis of an impact codified in the final rule is incorrect, the NRC staff will seek Commission approval to either suspend the application of the rule on a generic basis with respect to the analysis or delay granting the renewal application (and possibly other renewal applications) until the analysis in the GEIS is updated and the rule amended. If the rule is suspended for the analysis, each supplemental EIS would reflect the corrected analysis until such time as the rule is amended.

c. If a commenter provides new, site-specific information which demonstrates that the analysis of an impact codified in the rule is incorrect with respect to the particular plant, the NRC staff will seek Commission approval to waive the application of the rule with respect to that analysis in that specific renewal proceeding. The supplemental EIS would reflect the corrected analysis as appropriate.

Id. at 28470.

This system has not worked well. In more than 13 years since adoption of the GEIS, not a single issue of new and significant information has resulted in a change to the GEIS as applied to a specific plant. In none of the 50 license renewal proceedings that have occurred has any issue previously deemed generic and classified as "Category 1" been recognized to be a site-specific "Category 2" issue, regardless of the strength of the evidence offered to support that view. Furthermore, no public petition to even *commence* a rulemaking proceeding to alter the GEIS designation of an issue as a generic "Category 1" issue based on new and significant information has been granted, let alone resulted in a change in the 1996 regulation and associated regulatory text. And, perhaps most tellingly, the NRC Staff has never found a single issue on which it thought the Commission should consider modifying the GEIS to accommodate a site specific issue previously believed to be generic and "Category 1." Stated differently, the concerns expressed by CEQ leading up to the 1996 rulemaking have been borne out by the States' unsatisfactory experience with the GEIS and its legacy of rigidity over the past 13 years. In short, the State of New York submits that the current approach does not comply with the National Environmental Policy Act or CEQ regulations such as 40 C.F.R. §§ 1502.9, 1508.27, and 1508.28 because it curtails consideration of new and significant information and site-specific concerns that were characterized – and then codified – as generic issues back in 1996.

This continuing over-rigidity in the NEPA process for license renewal stems from fundamental flaws in the GEIS process:

1. The reference standard relied on by NRC Staff is circular and lacking standards. Staff refers to an internal and informal Regulatory Guidance document to evaluate petitions to change the GEIS and its associated regulation. That document, known as *Regulatory Guide 4.2, Supplement 1* states that new and significant information is information that identifies a significant environmental

issue not considered in the 1996 GEIS or information that was not considered in the GEIS and leads to an impact finding that is different from the impact finding listed in the 10 C.F.R. Part 51. *Regulatory Guide 4.2*, at 4.2-S-4 (ML003710495). This Regulatory Guide contains no real criteria for Staff to use – or the public to review so that they may have the opportunity to hold Staff accountable.

2. There are no criteria in the GEIS for analyzing whether an issue previously classified in 1996 as "generic" should be examined in a later supplemental EIS on a facility-specific or site-specific basis.

3. The current mechanism for identifying and addressing new and significant information is cumbersome and ineffective. Limiting the determination of whether there is new and significant information only to the licensee and the principal author of the original determination -- i.e., the NRC Staff -- is inherently flawed and unlikely to produce change. Sending parties to the rulemaking process creates enormous costs and potential delays in the licensing process and, has never been successful.

The question of whether new and significant information has been presented and whether that information warrants a site-specific analysis of an issue should be made by an independent authority with a mandate to fairly consider the evidence – and in accordance with NEPA, CEQ regulations, and judicial decisions that provide standards for evaluating whether or not a report, study, or event constitutes new and significant information. These comments propose that an Atomic Safety and License Board could ably fill that task and propose a mechanism that would not unnecessarily interfere with the license renewal decision-making process. Indeed, such a process could expedite resolution of such issues when compared to the current system.

The NRC may evaluate environmental impacts of a proposed licensing action on a generic basis – but only if the resulting environmental impacts do not turn on site-specific differences among plants. *Baltimore Gas & Electric Co. v. NRDC*, 462 U.S. 87, 101 (1983); *see also Massachusetts v. U.S.,* 522 F.3d 115, 127 (1st Cir. 2008); *Limerick Ecology Action, Inc. v. NRC*, 869 F.2d 719, 738 (3d Cir. 1989). Thus, where the impact may vary from site to site or the proposed mitigation measures depend on a facility's specific characteristics, that impact should be subjected to site-specific review under NEPA. For example, the actual impact on the local fish populations caused by once-through cooling will vary from site to site because the consequences of once-through cooling will differ among the different aquatic organisms and different ecosystems present at different sites – even though the mechanisms by which the fish are impacted may share a common descriptive term (*e.g.*, impingement, entrainment, or elevated temperature).

The 1996 GEIS sought to develop a test to determine whether an environmental impact was generic or site-specific and includes the following criterion for Category 1, generic findings, and Category 2, site-specific findings:

> The numerical entries in this column are based on the following category definitions:
>
> Category 1: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown:
>
>> (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;
>>
>> (2) A single significance level (i.e., small, moderate, or large) has been assigned to the impacts (except for collective off site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal); *and*
>>
>> (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.
>
> The generic analysis of the issue may be adopted in each plant-specific review.
>
> Category 2: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown that one or more of the criteria of Category 1 cannot be met, and therefore additional plant-specific review is required.

10 C.F.R. Part 51, Subpart A, Appendix B, Table B-1, footnote 2.

Notwithstanding this apparently clear distinction between site-specific impacts and generic impacts, as noted above, no issue has ever been "moved" from Category 1 to Category 2 during the more than 50 license renewal proceedings that have occurred since 1996. Rather, NRC and its staff have systematically rejected such attempts in the license renewal context, and no effective mechanism to challenge such rejections is available. *See, e.g., In re Entergy Nuclear Vt. Yankee LLC,* (Pilgrim and Vermont Yankee Nuclear Power Stations), 65 NRC 13, 21 (2007); *In re Fla. Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), 54 NRC 3 (2001). During those 13 years, NRC has relied on the immutable regulatory text to preclude inquiry into what issues are appropriate for generic treatment and which require site-specific treatment and when new and significant information warrants a change to the existing practice. During that time, it has been the unshakable view of NRC Staff that nothing has happened (prior to the pending rulemaking proceeding) that was sufficiently new and significant to warrant a modification to the GEIS. However, during that time, substantial changes did occur that should have triggered supplemental review of the GEIS's earlier analyses, but did not. What follows are a few examples:

1. Since 1996, a number of states have deregulated public utilities to varying degrees and this trend has decoupled energy generators and energy distributors. The former are treated as "merchant" plants in deregulation states and various "independent system operators" exercise less control over long term planning than was previously exercised by various Boards of Public Utilities. This structural change undercuts the factual basis for the GEIS's 1996 assumption that issues, such as need for power, would be addressed by state regulators and that the only issue at the power reactor relicensing stage would be whether to keep the "option" of such energy production available for consideration by a state utility regulator.

2. Various spent fuel pools have released radionuclides into the environment surrounding the reactors. NRC recently acknowledged that leaks can develop in [spent-fuel pools] and go undetected for long periods of time absent appropriate monitoring, resulting in the contamination of onsite groundwater and the potential for undetected, unevaluated releases of radioactivity to an unrestricted area.

3. In 1996, Sandia National Laboratories published a report concerning the clean up costs from accidental radiation dispersion. *Site Restoration: Estimation of Attributable Costs from Plutonium-Dispersal Accidents*, SAND 96-0957, Unlimited Release, UC-502, (May 1996). This report indicated that clean-up and disposal costs could be substantially greater than previously assumed.

4. In 2003, James Lee Witt completed a report that concluded that the Federal

Emergency Management Agency's evacuation plan for the area around the Indian Point facilities was deficient. In 2005, Hurricane Katrina demonstrated to the Nation that FEMA's emergency evacuation program was deficient.

5. Various regulatory authorities including NRC recognized that previous methods for projecting atmospheric dispersion of radionuclides were not realistic for sites with complex terrain or beyond certain distances. *See, e.g.*, Directory of Atmospheric Transport and Diffusion Consequence Assessment Models, Office of the Federal Coordinator for Meteorology, FCM-13-1999 (March 1999), available at www.ofcm.gov/atd_dir/pdf/maccs2.pdf (identifying concerns about straight line Gaussian air dispersion model).

6. The U.S. Geological Survey has informed NRC that various reactor sites in the central and eastern United States face a higher seismic hazard than previously thought.

7. The understanding of fire risk posed by the dense storage of spent fuel in spent fuel pools has changed and it is recognized that a loss of coolant incident could rapidly lead to a spent fuel fire and release of radionuclides.

8. Since 1996 the reality of terrorism directed at nuclear power plants in general and spent fuel storage pools at plant sites in particular, has become obvious and yet the GEIS continues to ignore the issue of what mitigation measures can and should be taken, on a site by site basis, to reduce the consequences of a successful terrorist attack. And for all sites and facilities that it regulates that are located within the territorial jurisdiction of the U.S. Court of Appeals for the Ninth Circuit, NRC's NEPA reviews now analyze the impacts of sabotage.

Because the current system has not provided an effective mechanism for States and the general public to seek modifications to the GEIS in light of these, and other substantial changes, the current system must be modified to provide an efficient and effective method to accommodate new and significant information.

In 1996 the Commission agreed with CEQ and the state commenters that in order to have a lawful generic environmental impact statement regarding issues relevant to license renewal it was essential to provide a mechanism for parties to modify the GEIS findings on specific issues when new and significant information demonstrated that a previous conclusion in the GEIS was no longer appropriate to use in a subsequent relicensing proceeding for a specific facility. What the Commission should now do is put in place a mechanism to fulfill that legally required commitment. Since leaving it to the NRC Staff or the cumbersome rulemaking petition process has not proven effective, the State of New York urges the Commission to create a special ASLB to hear claims, with regard to individual license renewal proposals, that specific issues should be allowed to be addressed in the license renewal proceeding even though such site-specific consideration may have been precluded by discussion in the GEIS (and then replicated in a regulation). This Board's sole mandate would be to determine these questions:

- Has an important factual predicate underlying the previous GEIS determination now changed?

- Is there material information that was not previously considered in developing the GEIS resolution of a particular issue?

- Does the information presented by a State or citizen intervenor provide a basis (as that term is interpreted under 10 C.F.R. § 2.309(f)) to support a different resolution of the issue including whether that different resolution is relevant to the particular license renewal proposal?

- Does the new information qualify as significant under the applicable CEQ regulations, 40 C.F.R. §§ 1502.9(c)(1), 1508.27?

Review by the Commission of a decision by this special ASLB would be subject to the same rights and limitations applicable to review of any decision on admissibility of a proposed contention in a licensing proceeding.

In addition, if NRC determines to retain the current criterion to distinguish generic and site-specific environmental impacts, it should instruct Staff to ensure that its analysis focuses on whether the *environmental impacts* themselves differ from facility site to facility site and not on whether the *mechanism* by which such environmental impacts may come about may have a common descriptive term, such as once-through cooling or impingement. Furthermore, the State notes that in the summary section of the proposed GEIS, Staff appears to using different wording in criterion 3 and calls on NRC to explain the significance of any such proposed change. Specifically, GEIS summary uses the phrase "would probably" in place of the phrase "are likely" that appears in the current regulation with the *Compare* 10 C.F.R. Part 51, Subpart A, Appendix B, Table B-1, footnote 2, criterion 3 *with* Proposed GEIS, p. S-5, criterion 3; *see also* Proposed GEIS at 4-2 - 4-3. The alternate "would probably" phrase also appears in the proposed draft Standard Review Plan. *See Draft Standard Review Plans*, NUREG-1555, Supp. 1, Rev. 1 at 6 (July 2009) ML090230497. This language difference is illustrated in the following chart:

10 C.F.R. PART 51, TABLE B-1, N.2, 61 FED. REG. 28467, 28496 (JUNE 5, 1996)	PROPOSED GEIS, S-5
(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.	(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures would probably not be sufficiently beneficial to warrant implementation.

NRC should explain whether it intends any there to be any difference between these two phrases.

With respect to the "new and significant information" question, NRC should formally repudiate the discussion contained in the current, standard-less *Regulatory Guide 4.2, Supplement 1* (Sept. 2000). This standard-less and circular discussion is inconsistent with NEPA, CEQ regulations, and federal court case law. Unfortunately, the proposed revised Regulatory Guide repeats the same standard-less discussion, *Draft Regulatory Guide DG-4015* (July 2009) ML091629409, and it too should be withdrawn and revised for the same reasons.

C. NRC Should Amend Its Existing and Proposed Regulatory System to Allowed for a Supplemental Review of Ways to Mitigate Environmental Impacts of Severe Accidents

In 1989, the United Stated Court of Appeals for the Third Circuit rejected NRC's ad hoc policy of examining severe accidents and instead ordered NRC to carefully evaluate the environmental impacts that could result from severe accidents and the means to mitigate such impacts in order to comply with NEPA. *Limerick Ecology Action, Inc. v. NRC*, 869 F.2d 719 (3rd Cir. 1989). The Third Circuit noted that NRC did not find that risks from a severe accident were remote and speculative, and held that NRC's severe accident policy did not represent the requisite careful consideration of the environmental consequences required under NEPA. 869 F.2d at 723. As a result, NRC regulations now require applicants and NRC Staff to conduct a severe accident mitigation alternatives (SAMA) analysis. 10 C.F.R. § 51.53(c)(3)(ii)(L).

Those regulations, however, limit the obligation to conduct a SAMA analysis to those plants where a SAMA analysis previously has not been considered for the plant during its initial licensing (*i.e.*, in the wake of the *Limerick* decision). In light of new analyses and insights about mitigation measures, changing population patterns, and economic variations over time, a SAMA analysis should be performed when a reactor applies for a renewed operating license, regardless of whether the facility went through a SAMA review twenty years before. It is unrealistic to expect that a SAMA analysis performed, for example, in 1990 would suffice for a facility seeking a renewed operating license in 2010 or 2030.

IV. Specific Comments

A. The State of New York Supports NRC's Proposal to Classify Leaks from Spent Fuel Pools and Pipes as Category 2 Environmental Impacts

The State of New York supports the proposed GEIS's reclassification of radionuclides released to groundwater as a Class 2 issue. *See* Proposed GEIS at B-12. As the NRC has acknowledged, recent events around the United States and the world – as well as at the Indian Point Nuclear Power Station – have demonstrated that various aging piping systems and tanks have experienced leaks and/or corrosion. These leaks and corrosion threaten the integrity of such systems and compromise their ability to achieve their intended function. As a result, a number of events have occurred where radioactively contaminated water has leaked into the ground from spent fuel pools, underground pipes, and potentially from other systems and components, and remained undetected for as long as 12 years. Analysis of these leaks, some of which have impacted drinking water sources, is only effectively done on a site-specific basis.

The following occurrences illustrate the problem underlying the importance of the NRC's proposed change to the GEIS:

- In August 2004, the owner of the Dresden Nuclear Power Plant in Illinois discovered an underground leak from the condensate storage tank piping. Tritium (also called "H-3") levels in onsite ground water monitoring wells were as high as 1,700,000 picocuries per liter ("pCi/L") in at least one well.and tritium was also detected in a nearby drinking water well. *See* NRC, Preliminary Listing of Events Involving Tritium Leaks (Mar. 28, 2006), ML060930382.

- In December 2005, tritium was detected in a drinking water well at a home near the Braidwood Nuclear Plant in Illinois. The "initial evaluation indicated that the tritium in the groundwater was a result of past leakage from a pipe which carries normally non-radioactive circulating water discharge to the Kankakee River, about five miles from the site. Several millions [sic] gallons of water leaked from the discharge pipe in 1998 and 2000." *See* NRC Preliminary Notification of Event or Unusual Occurrence PNO-RIII-05-016A, "Potential Off-site Migration of Tritium Contamination (Update)" (Dec. 7, 2005), ML053410293.

- In March 2006, a leak was discovered at Palo Verde Nuclear Generating Station in Arizona. *See* NRC Preliminary Notification of Event or Unusual Occurrence, PNO-IV-06-001, "Followup For Tritium Contamination Found In Water Onsite" (March 17, 2006), ML060760584. An analysis of the ground water revealed tritium levels of 71,400 picocuries/Liter (pCi/L). *Id.* The Arizona Republic reported on March 4, 2006 that, "Arizona Public Service Co. discovered radioactive water near a maze of underground pipes at the Palo Verde Nuclear Generating Station...and tests confirmed that the water contains more than three times the acceptable amount of tritium." Radioactive Water Found at Palo Verde, Ken Alltucker, The Arizona Republic (Mar. 4, 2006).

- In October 2007, high levels of tritium were detected in the groundwater under the Catawba Nuclear Power Station located in York, South Carolina. At one groundwater monitoring well, the tritium measured 42,000 pCi/L. *See* NRC Preliminary Notification of Event or Unusual Occurrence, PNO-II-07-012, "Onsite Groundwater Tritium Contamination" (Oct. 11, 2007), ML073111396.

- That same week, high levels of tritium were discovered in the groundwater at the Quad Cities Nuclear Power Station located in Warrenville, Illinois. The tritium levels measure up to 800,000 picocuries per litre. *See* NRC Preliminary Notification of Event or Unusual Occurrence, PNO-III-08-011, "Tritium Leakage" (Oct. 11, 2007), ML 072890262. "Underground piping from the condensate water storage tank is being examined as a possible source." *Id.*

- Seven days later, on October 19, 2007, a leak was discovered in piping within the essential service water system that serviced both reactors at the Byron Nuclear Power Station located in Byron, Illinois. *See* NRC Preliminary Notification of Event or Unusual Occurrence, PNO-III-07-012, "Both Units at Byron Shut Down Due to a Leak in Pipe" (Oct. 23, 2007), ML072960109. The NRC then announced that had begun a special inspection at the Byron Nuclear Power Station to review the circumstances surrounding the corrosion of piping in the equipment cooling water system and subsequent leak in one pipe. "As a result of the leakage, reactor operators shut both reactors down on Friday, Oct. 19, to repair the leak and inspect similar pipes. The pipes carry water from the plant where it is used for cooling of essential safety equipment back to basins under fan-driven cooling towers." *See* NRC Press Release, III-07-24, "NRC Begins Special Inspection at Byron Nuclear Station to Review Corrosion and Leakage of Equipment Cooling Water Pipe" (October 23, 2007), ML072960643.

- Similar leaks have been detected at other nuclear power plants in New Jersey (Salem) and Connecticut (Haddam) as well as the spent fuel pool at the Brookhaven National Laboratory on Long Island. *See* NRC Office of Nuclear Reactor Regulation, "Spent Fuel Pool Leakage To Onsite Groundwater," NRC Information Notice 2004-05, March 3, 2004 (Salem, New Jersey, Nuclear Power Generating Station); NRC Office of Nuclear Reactor Regulation, "Ground-Water Contamination Due to Undetected Leakage of Radioactive Water," NRC Information Notice 2006-13, July 10, 2006 (discussing leaks at Haddam Neck and other nuclear power plants); General Accounting Office, Information on the Tritium Leak and Contractor Dismissal at the Brookhaven National Laboratory (GAO/RCED-98-26) November 1997. These NRC and GAO documents are incorporated herein by reference.

- In the Spring and Summer of 2009 unregulated tritium leaks were detected at the Oyster Creek Nuclear Power Station shortly after that facility received a renewed operating license.

- In December 2009, tritium was detected in a water sample taken from an exterior sump at the Fitzpatrick Nuclear Power Station in Scriba, New York.

- In January 2010, tritium was detected in a monitoring well at Vermont Yankee Nuclear Generating Station in Vernon, Vermont at levels of 17,000 picocuries per liter. *See* Bob Audette, Tritium Leak Found at VY, Brattleboro Reformer (Jan. 8, 2010).

In September 2005, during planned excavation adjacent to the Indian Point Unit 2 spent fuel pool, Entergy discovered cracks in the concrete wall caused by shrinkage during the concrete curing process that leaked spent fuel pool water. Upon further investigation, the licensee determined that groundwater underlying portions of the Indian Point Nuclear Power Station site was contaminated with tritium due to possible leakage from the spent fuel pool or other on-site sources. Monitoring well tests conducted throughout the site showed tritium levels reaching as high as 400,000 to 600,000 pCi/L. *See, e.g.,* NRC Advisory Committee on Reactor Safeguards Subcommittee on License Renewal, Transcript (Mar. 4, 2009) at 81; NRC Information Notice 2006-13, Ground-Water Contamination due to Undetected Leakage of Radioactive Water (July 10, 2006), at 3. On February 27, 2006, a sample showed tritium contamination levels of 30,000 pCi/L at a location close to the Hudson River. *See* Indian Point Nuclear Generating Unit 2 - NRC Special Inspection Report No. 05000247/ 2005011 (Mar. 16, 2007) ML060750842).

On March 21, 2006, Entergy announced that samples taken from an on-site monitoring well located near the Hudson River also showed detectable levels of strontium-90; Entergy also has identified elevated levels of nickel-63 and cesium in groundwater under the Indian Point Nuclear Power Station. *See* Jim Fitzgerald, *High Levels of Strontium-90 Found in Indian Point Groundwater*, Associated Press, Mar. 21, 2006; Greg Clary, *Indian Point Leak of Radioactive Element Spreads*, Poughkeepsie Journal News, Mar. 22, 2006; E-mail from Donald Croulet of Entergy to James Noggle of USNRC, "regarding H-3 sources IPEC-RL-Comments-1" (attachment, table) (Dec. 12, 2005), ML061000598.

The plumes of tritium and strontium leaking from Indian Point's spent fuel pools have reached the Hudson River. *See* Entergy Indian Point Environmental Report submitted April 30, 2007, at p. 4-87 (stating that Entergy and the NRC have concluded that "... there appears to be some level of contaminated groundwater that discharges to the Hudson River..."). In addition, in the Fall of 2007, the NRC and Entergy confirmed that a leak developed in the concrete transfer canal between Unit 2 and its associated spent fuel pool. Water contaminated with radioactive nuclides leaked through the crack in the transfer canal. *See* Email, Kathleen McMullin, Entergy, to Eugene Coby, *et al.*, NRC, "IPEC status report for Sept. 6 2007," ML072970221.

A January 2008 report on a hydrogeological study at Indian Point illustrates the extent of the subsurface contamination at the site and the migration of the radionuclides to and under the Hudson River. *See Hydrogeologic Site Investigation Report* (GZA GeoEnvironmental, Inc., Jan. 7, 2008) ("*GZA Report*") Figures 9.4 – Current Unit 1 Activity Isopleths, Figure 9.3 - Current Unit 2 Activity Isopleths. In addition, the report identified radionuclide contaminated plumes at depths ranging from 80 feet (below Indian Point 2) to 160 feet (near the Hudson River bank) for tritium, and from 120 feet (below Indian Point 1) to 150 feet (near the Hudson River bank) for strontium 90. *GZA Report*, Figure 9.1 - Unit 2 Tritium Plume, Cross Section A - A' and Figure 9.2 - Unit 1 Strontium Plume, Cross Section B - B'. Attached to these comments as Exhibit A are copies of various figures from the GZA Report that depict the subsurface contamination at Indian Point.

In February 2009, another underground leak was detected in a condensate return line at Indian Point Unit 2. Entergy estimated that the pipe had been leaking fluid at the rate of 17 gallons per minute or approximately 24,000 gallons per day. *See* Root Cause Analysis Report, CST Underground Recirc Line Leak, CR-IP2-2009-00666 (April 14, 2009) at 9. On April 7, 2007 a leak was detected in a buried steam pipe that connected Indian Point Unit 1 with Indian Point Unit 3. *See* Condition Report CR-IP3-2007-01852. Tritium was detected in samples taken from both the 2009 condensate line leak and the 2007 steam line leak.

One common aspect of many of these leaks – around the nation and at Indian Point – is that they have been discovered by happenstance and that they usually have gone undetected for an extended period of time thereby permitting increasingly larger amounts of contaminated water to enter the ground (or air) around the facilities. *See* NRC, Liquid Radioactive Release Lessons Learned Task Force Final Report, Sept. 1, 2006, at ii, ML071420239. Therefore, the NRC's revised GEIS, which would require site-specific analysis of radionuclides released to groundwater, offers an extremely important mechanism by which contamination can be detected and remedied at the license renewal stage, which may result in the discovery of groundwater contamination which had not been previously identified.

B. The Revised GEIS Should Require That SAMA Analyses Use Air Dispersion Models That Can Incorporate the Impacts of Complex Terrain on the Dispersion of a Radioactive Plume So That the Cost of Human Radiation Exposure and Property Damage from a Severe Accident Can Be Accurately Determined And Alternatives Can Be Identified and Evaluated.

As previously discussed, NRC's NEPA regulations now require facilities, such as Indian Point, to conduct a severe accident mitigation alternatives analysis if NRC Staff has not previously considered such an analysis. 10 C.F.R. § 51.53(c)(3)(ii)(L). Given the importance of such an analysis to the citizens residing near the facility, it is critical that this SAMA analysis be accurate and transparent. The State of New York has concerns that the typical SAMA analysis does not account for the various site specific characteristics at Indian Point, such as the site's population distribution, meteorology patterns, and complex topography.

The proposed GEIS contains a new section entitled "Meteorology and Climatology" which sets forth NRC's requirement that "basic meteorological information" be available to "determine dispersion conditions in the vicinity of the plant for assessment of safety and environmental factors." Proposed GEIS at 3-30. As the NRC explains, "these data are used with air dispersion models to protect public health, safety and property during plant operations." *Id.*

The Proposed GEIS further explains that the NRC has recently updated its Regulatory Guide 1.23 for onsite meteorological monitoring – a guide that covers instrument siting, accuracy and range of specified measured parameters, and "*special considerations for plants located near influences of complex terrain (e.g. coastal areas, hills of significant grade or valleys).*" (emphasis added). *Id.* at 3-30 – 3-31.

The State of New York agrees that nuclear power plants located in complex terrain, such as Indian Point, should perform onsite meteorological monitoring that will measure the effects of complex terrain on wind direction, velocity and other factors relevant to the dispersion of a radioactive plume during an accident.

However, the collection of such "complex terrain" meteorological measurements is only relevant if these data are then used in an air dispersion model which itself is capable of incorporating the effects of complex terrain in its projection of the dispersion and concentration of a radioactive plume. Accurate air dispersion modeling is critical to an accurate SAMA analysis for Indian Point because it is sited in an area in which the population density within the 10 and 50 mile EPZs varies substantially, from sparsely populated semi-rural areas to the densely populated environs of New York City. Therefore, different directional dispersions of a radioactive plume can cause substantially different human exposures.

Unfortunately, in its air dispersion modeling in the NEPA process and elsewhere, NRC has consistently used a simple straight-line Gaussian plume model, which the scientific community, the Environmental Protection Agency staff, and even NRC staff have acknowledged is not appropriate for air dispersion modeling for reactors in complex terrain (*e.g.*, hilly, mountainous, or otherwise non-uniform terrain) such as the terrain surrounding Indian Point, which has many peaks and valleys. *See* NUREG-1437, Vol. 1, Supp. 38, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 (Dec. 2008) at 2-2.1 for a description of the terrain surrounding Indian Point. In the Indian Point license renewal proceeding, the State challenged the NRC's acceptance of Entergy's use of a straight line Gaussian plume model known as ATMOS in its SAMA analysis and that contention was admitted by the Licensing Board. Attached hereto are two declarations of Bruce A. Egan, executed November 27, 2007 (Ex. B)(ML092610911) and August 28, 2009 (Ex. C)("Egan 2009 Decl.")(ML092610916),[2] submitted by the State of New York in support of its contention, which explain the inadequacy of such straight line Gaussian models in complex terrain and set forth the similar conclusion of the U.S. Environmental Protection Agency, the U.S. Department of Energy and the NRC (in contexts other than the SAMA analysis required for license renewal). *See, e.g.*, Egan 2009 Decl. at ¶¶ 54-57, 59.[3]

As Dr. Egan explains, there are several effects of the terrain at Indian Point

[2] Because of their length and size, the attachments to the Declaration of Bruce Egan are not attached but are incorporated herein. They can be found at ML092610910, ML092610912, ML092640223, ML092640221, ML091050257, ML092640169, ML092640173, ML092640170, ML092640171, ML092640172, ML092640174, ML092640175, ML092640177, and ML092640178.

[3] Dr. Egan has a Master of Science Degree in Engineering in Applied Physics, and a Master of Science and a Doctorate in Environmental Health Sciences, all from Harvard University. He has over 30 years experience as a manager and environmental scientist on projects involving the development and application of atmospheric dispersion models to complex topographies.

on air flow, which cannot be accounted for by the ATMOS air dispersion model, a module within the MACCS2 accident consequence code. In the case of high terrain features across the river from Indian Point, air flow from the east will either turn and pass along the side of the mountain or rise over the mountain, depending upon atmospheric stability conditions. Egan 2009 Decl. at ¶ 39. Therefore, a radioactive plume released from Indian Point and embedded in the air flow will not take the straight line trajectory across the river valley that would be predicted by the ATMOS model. *Id.* Under the more stable atmospheric conditions associated with greater ground level impacts, the plume is likely to be turned down the overall river valley as it cannot pass through the terrain. *Id.*

A second effect of mountainous terrain on sources located in river valleys, such as Indian Point, is the creation of drainage flows by the presence of the valley side walls. Egan 2009 Decl. at ¶ 40. For example, at night when the earth's surface cools by radiating its heat upward, the air in contact with the surface cools. Because it is heavier than other air at that elevation, it flows, under the forces of gravity down the valley slopes toward the base of the valley. *Id.* In the absence of other influences, the pooling of the heavier air at the low point of the valley cross-section causes that air to tend to flow downriver, following the valley contours. *Id.*

Meteorological models that incorporate the effects of topography will simulate the phenomenon of valley sidewalls tending to channel air within the confines of the valley flows to follow the valley contours. Egan 2009 Decl. ¶ 41. Nighttime drainage flows in river valleys will tend to stay in river valleys and flow in the same direction as the river itself. *Id.*

A straight line Gaussian plume model cannot account for these phenomena, which could cause a night time radionuclide release to travel downriver toward the most populous areas in the fifty mile radius around Indian Point, including New York City and its surrounding suburbs. *See* Egan 2009 Decl. ¶¶ 39-42. The reasons that the straight line Gaussian model does not accurately predict air dispersion in complex terrain are fundamentally related to these multiple effects that the presence of high terrain has on altering the air flow.

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 2009 Decl., ¶¶ 48-57. These agencies and experts advocate for the use of alternate, more appropriate plume models such as CalPUFF or Calmet. *See* Egan 2009 Decl., ¶ 30.

Notwithstanding this overwhelming consensus of scientific opinion, the NRC continues to rely on an outmoded straight-line Gaussian plume model to conduct the

SAMA analysis which may underestimate the costs of an accident to which the cost of a mitigation measure will be compared. For example, Entergy is only required to consider measures to mitigate the likelihood or severity of a severe accident, if the costs of the accident outweigh the cost of the mitigation measure. NEI 05-01 Rev. A, *Severe Accident Mitigation Alternatives Analysis – Guidance Document* at pages 1-3.[4] Human exposure to radiation is one cost of a severe accident, and is computed based on a cost of $2,000 per person rem of exposure. *Id.* at 16. For the human exposure cost to be accurately estimated, the air dispersion model must be able to account for the complex terrain features surrounding the plant so that the numbers of people exposed can be accurately projected. ATMOS, the air dispersion model embedded in the MACCS2 accident consequence code, is a simple straight-line Gaussian plume model which cannot accurately predict the path of a radioactive plume emitted during a severe accident.

In sum, although the State agrees with the NRC that on-site meteorological measurements should contain "special considerations for plants located near influences of complex terrain (*e.g.,* coastal areas, hills of significant grade or valleys)," those measurements are only meaningful if the NRC uses them in more sophisticated air dispersion models that can incorporate the effects of complex terrain on the dispersion of a radioactive plume released during a severe accident at Indian Point. The State of New York thus seeks a modification of the draft GEIS to require the use of more sophisticated air dispersion models that can accurately account for the cost of human exposure to radiation in cases where the local terrain warrants use of such sophisticated models.

C. Effective Emergency Preparedness and Evacuation Planning Is Critical to Mitigate the Immediate Public Health and Environmental Impacts of a Severe Accident And Should Be Considered as a Category 2 Issue In the NEPA Environmental Analysis of a Proposed License Renewal

In 1983, in response to the 1979 reactor core melt at Three Mile Island and studies such as the 1975 Reactor Safety Study, NRC announced its Safety Goal Development Program based on a "defense-in-depth approach . . . in order to prevent accidents from happening and to mitigate their consequences" through "siting in less populated areas" and "emergency response capabilities." 48 Fed. Reg. 10,772, 10,775 (1983) ("Safety Goals Policy Statement"). Thus, NRC acknowledges that emergency planning and evacuation measures can mitigate the environmental impacts of a radiation release. As such emergency planning and evacuation measures should be examined as part of the NEPA analysis that takes place as part of the process to

[4] This guidance document from the Nuclear Energy Institute was endorsed by NRC Staff in LR-ISG -2006 - 03 at pages 1-3.

determine whether or not an operating license should be renewed.

The Proposed GEIS continues to exclude from the environmental impact review of relicensing any analysis of the actual effectiveness of emergency preparedness and evacuation planning in the event of a radiological emergency at a relicensed nuclear power plant. The NRC also does not consider this issue at any other stage of the relicensing proceeding. The State of New York objects to this exclusion of emergency planning and evacuation from the NEPA analysis, particularly as it relates to Indian Point, where effective evacuation is critical if environmental impacts from a design basis accident or a severe accident are to be mitigated.

NRC itself has indicated with regard to emergency planning, these "regulations are premised on the assumption that a serious accident might occur and that evacuation of the EPZ might well be necessary." *In the Matter of Philadelphia Electric Co.* (Limerick Generating Station, Units 1 and 2), 22 N.R.C. 681, 713 (ALAB Oct 22, 1985). Each licensee is required to establish emergency preparedness plans which are to be implemented in the event of an accident, including protective action measures for the public. 10 C.F.R. § 50.47. Given that federal agency action under consideration and review is the decision by NRC to renew a NRC operating license and given that NRC does not allow the State to have any decision-making role in NRC's siting of a reactor or the renewal of its operating license, NEPA imposed on the NRC the obligation to undertake a transparent and comprehensive review of the plans to ensure that on- and off-site emergency evacuation plans can mitigate environmental impacts in the event of a radiological emergency. The plans must provide for two emergency planning zones (EPZs); (i) a plume exposure pathway EPZ (requiring preplanned evacuation procedures) of about 16 km (10 miles) in radius and (ii) an ingestion exposure pathway EPZ of about 80 km (50 miles) in radius. 10 C.F.R. § 50.47. Other standards include appropriate ranges of protective actions for each of these zones; provisions for dissemination to the public of basic emergency planning information; provisions for rapid notification of the public during a serious reactor emergency; and methods, systems, and equipment for assessing and monitoring actual or potential off-site consequences in the event of a radiological emergency condition. 1996 GEIS at 5.2.3.3. Once a major radiological release occurs, effective emergency and evacuation plans are the only method of substantially mitigating the immediate public health and environmental impacts of radiation exposure. Nevertheless, the 1996 GEIS excludes emergency planning and evacuation as a mitigation measure that must be analyzed before a plant's license is renewed. 1996 GEIS at 5-10; Table 9 at pages 9-2 through 9-6.

Despite the fact that effective emergency planning is the sole method of substantially mitigating the immediate impacts of a serious radiological release, the NRC's Proposed GEIS continues to exclude any consideration or analysis of a license renewal applicant's emergency planning and preparedness in the environmental impact review process. Proposed GEIS at 1-10. The exclusion of emergency preparedness from the environmental review continues despite the NRC's stark acknowledgement in its 1996 GEIS that "evacuation can have a significant influence on early fatality risk" (1996 GEIS at 5-24) and early fatalities are surely an environmental impact of a radiological emergency.

The effectiveness of emergency preparedness and evacuation is particularly critical at Indian Point and at other plants near large population centers which would likely not be granted an original operating license today because they would fail to meet key license criteria with regard to population density and the difficulties it raises for evacuation planning. 10 C.F.R. § 100.21(h). As NRC's former director of the Office of State Programs said in 1979, "it is insane to have a three-unit reactor on the Hudson River in Westchester County, 40 miles from Times Square, 20 miles from the Bronx . . . [it is] one of the most inappropriate sites in existence," Robert Ryan, NRC's Director of the Office of State Programs, *Report of the Office of the Chief Counsel on Emergency Preparedness to the President's Commission on the Accident at Three Mile Island, October 31, 1979.*

Rather than require license renewal applicants near densely populated areas to establish the actual efficacy of their emergency preparedness plans in order to continue operating their plants for another twenty years, the NRC determined that there is "no need for a special review of emergency planning issues" before a license is renewed because oversight of emergency preparedness and evacuation plans is "ongoing and outside the regulatory scope of license renewal." Proposed GEIS at 1-11, 1-12. In other words, NRC assumes that its ongoing regulatory process ensures adequate emergency planning.

Developments since the 1996 GEIS make the NRC's confidence in the ongoing regulatory process untenable and demonstrate that effective emergency preparedness and evacuation plans will almost certainly not be in place in the event of a radiological emergency. For example, the NRC's conclusion that the ongoing regulatory process is adequate to protect people in the event of an emergency is premised, in part, on the assertion in Section 1.7.3 of the Proposed GEIS that "nuclear power plant owners, government agencies, and State and *local officials* work together to create a system for emergency preparedness and response that will serve the public in the unlikely event of an emergency." (emphasis supplied). The NRC also asserts that "each plant owner is required to exercise its emergency plan with the NRC, FEMA, and offsite authorities at least once every two years to ensure that State and local officials remain proficient in implementing their emergency plans." *Id.* at 1-11. Thus the Proposed GEIS assumes that the licensee's emergency and evacuation plan will create a smooth integration of the various government agencies that would be involved in an emergency, and that a continuing testing of the efficacy of that integration between federal, State and local officials will be conducted.

However, changes in the real world since the 1996 GEIS wholly undermine the NRC's assumptions about the smooth interlocking of the various agencies involved during an emergency. For example, the Proposed GEIS's assumption that plant owners, "government agencies and State and local officials work together to create a system for emergency preparedness" (Proposed GEIS at 1-10) is clearly unwarranted; since 2003, the county governments of Westchester, Rockland, and Orange have refused to provide the annual certification for the emergency plans based on their concern that those plans are inadequate to protect the public and have refused to participate in exercises based on them. *See, e.g.*, January 17, 2003 letter from E. Diana, Orange County Executive, to E. Jacoby, New York State Emergency Management Office, ML030350231. The NRC is thus left to rely on Executive Order No. 12657, signed by President Reagan in 1988, that applies "whenever State or local governments, either individually or together, decline or fail to prepare commercial nuclear power plant radiological emergency preparedness plans," and specifically requires that "FEMA shall substitute its own resources for those of the State and local governments only to the extent necessary to compensate for the nonparticipation or inadequate participation of those governments." Exec. Order No. 12657, Section 2(b)(2) (Nov. 18, 1988).

However, the State and Federal Governments are not realistically in a position to step in and implement evacuation plans for the counties which are closest to the problem but have declined to participate or cooperate. Although FEMA may claim confidence in its ability to carry out an evacuation plan in the absence of local government cooperation, Hurricane Katrina exposed such judgments as risky and questionable. Even the White House's report on Katrina noted that "[w]ith respect to evacuation—fundamentally a State and local responsibility—the Hurricane Katrina experience demonstrates that the Federal government must be prepared to fulfill the mission if State and local efforts fail. Unfortunately, a lack of prior planning combined with poor operational coordination generated a weak Federal performance in supporting the evacuation..." *The Federal Response to Hurricane Katrina – Lessons Learned*, United States White House, Washington, D.C. (Feb. 2006) at 56. The potential failure of first responders and emergency professionals to respond to catastrophic emergencies in a timely way, and the possibility of panic ensuing from a fast breaking emergency scenario undermines the Executive Order's conclusion that the federal government will just get the evacuation 'job' done regardless of reality. *See* Declaration of Raymond C. Williams (Nov. 27, 2007) at ¶¶ 26, 28 ("Williams Decl.")(ML073400193)(Ex. D). Moreover, the county governments' doubts about the evacuation plan's adequacy are well-founded. In 2003, a comprehensive review of the effectiveness of the NRC-approved evacuation plans for Indian Point was conducted by James Lee Witt Associates ("JLWA") which resulted in a report entitled *Review of Emergency Preparedness of Areas Adjacent to Indian Point and Millstone.* ("2003 Witt Report")(*available at* http://www.witt associates.com/upload/wysiwyg/NYReport.pdf).[5]

The 2003 Witt Report highlighted "significant planning inadequacies, expected parental behavior that would compromise school evacuation, difficulties in communications, outdated vulnerability assessment, the use of outdated technologies, lack of first responder confidence in the plan(s), problems caused by spontaneous evacuation, the nature of the road system, the thin public education effort, and how these issues may impact an effective response in a high population area." 2003 Witt Report at viii. The report concluded that "none of these problems, when considered in isolation, precludes effective response. When considered together, however, it is our conclusion that the current radiological response system and capabilities are not adequate to overcome their combined weight and protect the people from an unacceptable dose of radiation in the event of a release from Indian Point." *Id.* This is especially true if the release is faster or larger than the typical exercise scenario. Williams Decl. ¶ 8.

Moreover, the Witt Report's conclusions are bolstered by a 2003 traffic study by KLD Associates, which concluded that evacuation times for the EPZ around Indian Point had doubled since 1994 and could take up to 9.25 hours in good weather conditions and 12 hours in snow conditions. KLD Associates, Inc., *Indian Point Energy Center Evacuation Time Estimates*, Table 7-1D, at 7-14 (2003) (hereafter "KLD Traffic Study")

Since the 2003 Witt Report, JWLA conducted another review of the emergency plans for Indian Point to determine if there has been any change to the conclusions about the failures of the evacuation plan originally identified in the 2003 Witt Report. Many such deficiencies remain. "[T]here were substantial issues with planning, training, and exercises that had to be resolved to ensure the safety of citizens in the surrounding areas from a significant radiological release from Indian Point. In particular, JLWA raised issues about outdated and ineffective aspects of the planning process, inadequate public outreach and education, outdated communications systems and hazard assessment technologies, lack of first responder confidence in plans, problems associated with spontaneous evacuation, the inadequacy of the road system, and the high population density within the ten-mile Emergency Planning Zone." Williams Decl., ¶ 7.

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[5] James Lee Witt was the Director of FEMA during the Clinton administration. Raymond C. Williams is an independent consultant for James Lee Witt Associates, with 32 years of professional emergency management experience, including 20 years employment with FEMA and 5 years with its predecessor agency, the Defense Civil Preparedness Agency. *See* Williams Decl. at ¶¶ 1-2.

In addition, the issues that the 2003 Witt Report and KLD Traffic Study raised about the road infrastructure surrounding Indian Point still exist. Based on information received by the counties, the road system around Indian Point is still not sufficient for a large-scale evacuation. The most recent figures from 2006 indicate that, in aggregate, the counties grew 4.49 percent from 2000 to 2006, with Orange County experiencing the greatest growth at 10.26 percent and Westchester the least at 2.8 percent. William Decl. ¶ 11. Population growth in areas served by rural roads makes the evacuation problems more difficult. *Id.*

Detailed analysis has concluded that the constraints of the roadways are significantly greater than earlier believed and that increases in population and population density further exacerbate the inability of the plan to adequately evacuate the population surrounding Indian Point. As a 2003 evacuation time estimate makes clear, "a 66% increase in the estimated time an evacuation would require in favorable weather conditions." Williams Decl. ¶ 12. The inadequacies in the evacuation plan and the further increase in population in the area underscore the need for a full analysis in the license renewal proceeding because these problems will increase and worsen over the next twenty years. It was due in large part to the information in the Witt Report and the and KLD Traffic Study, that three out of the four county governments with territory in the 10 mile EPZ for Indian Point – Westchester, Orange and Rockland – have refused to cooperate with updating the Indian Point evacuation plan or in exercises to test the plan. *See* Randal C. Archibold, *3 Counties Maneuver in Bid to Close Down Indian Point*, N.Y. TIMES (Jan. 16, 2003).

In fact, in the 1996 GEIS, the NRC recognized that the "changing environment" in which a plant exists during the license renewal period, particularly an increase in the general population in the vicinity of a plant, can cause an increase in public risk as the plant continues to operate, "because the number of people that will need to be evacuated or otherwise protected from radiation exposure will increase. 1996 GEIS at 5-11. As the NRC acknowledged in the 1996 GEIS, these "changing environment" impacts are "noncontrollable," and therefore their potential for increasing risk as well as the magnitude of any such increase in risk must be "specifically examined." 1996 GEIS at 5-11.

The NRC's attempt in the 1996 GEIS to "specifically examine" the increased risk due to future population growth is flawed, as it relates to Indian Point. For example, the 1996 GEIS purports to predict increases or decreases in accident consequences risks during a plant's relicensing term, in part by applying certain risk factors to population figures within the 50 mile radius at the middle year of the license renewal. 1996 GEIS at 5-20 – 5-25. Table 5.3 of the 1996 GEIS asserts that the population within the 50 mile radius of Indian Point in 2030, (the middle year of license renewal) will be 15,195,541 and the population in the highest frequency wind direction in the 50 mile radius will be 602,427. These population figures are substantially underestimated, considering that the 50 mile radius population in 2009 is already more than 17,000,000. *See* Edwin Lyman, *Chernobyl on the Hudson? The Health and Economic Impacts of a Terrorist Attack at the Indian Point Nuclear Plant* (2004) at 23 (extrapolating 2009 population from 2000 Census data)(*available at* http://www.ucsusa.org/assets/documents/nuclear_power/indianpointhealthstudy.pdf). Thus, the NRC's alleged continuing review of emergency preparedness and evacuation planning cannot be relied on, if the NRC is assuming a substantially smaller population in the vicinity of the plant in 2030 than actually exists in 2009 when a substantially larger population will likely exist in 2030 during the middle year of license renewal.

In sum, the NRC's on-going oversight of emergency preparedness and evacuation plans for the EPZ of Indian Point has been wholly inadequate to ensure that the public is protected during a radiological emergency. Therefore, the effectiveness of the NRC-approved emergency plans must be considered in the NEPA analysis of the Indian Point license renewal application as a Category 2 site-specific issue. Indeed, because emergency evacuation is such a critical method of mitigating or avoiding the severe acute health impacts of radiation exposure, the effectiveness of emergency planning and evacuation must be considered in the NEPA analysis of all license renewal applications, not just Indian Point's, as a Category 2 issue because site-specific conditions will predominate in devising effective evacuation plans.

D. The Proposed GEIS Improperly Categorizes Offsite Land Use Impacts As Category 1

The State of New York disputes the new characterization of offsite land use impacts in the Proposed GEIS as Category 1. *See* Proposed GEIS at 2-6 (Table 2.1-1), 4-7. The 1996 GEIS properly characterized impacts on offsite land use as a Category 2 issue that required a site-specific analysis by a license renewal applicant. However, relying on "license renewal reviews" subsequent to the 1996 GEIS, the Proposed GEIS concludes that "the impact of continued plant operations during the license renewal term and refurbishment on offsite land use would be small at all plants," and therefore "is a Category 1 issue." *Id.* at 4-7.

Category 1 issues are those that meet *all* of the following criteria:

> (1) The environmental impacts associated with the issue were determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (*i.e.*, small, moderate, or large) was assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from the disposal of high-level waste and spent fuel).

(3) The mitigation of adverse impacts associated with the issue was considered in the analysis, and it was determined that additional plant-specific mitigation measures would probably not be sufficiently beneficial to warrant implementation.

Proposed GEIS at 4-2 - 4-3. Absent "new and significant" information, applicants need not analyze plant-specific impacts of Category 1 issues. *Id.* at 4-3. The Proposed GEIS thus would absolve individual license renewal applicants from having to analyze the impact of license renewal or non-renewal on offsite lands near their facilities.

In arriving at this determination, the Proposed GEIS identified only two categories of potential impacts on offsite land use: plant-related population changes and changes to tax revenues. *See* Proposed GEIS at 4-7. No other potential impacts were identified or analyzed. *See id.* Looking only at these two potential impacts, and looking only at data purportedly derived, but not identified, from post-1996 license renewal reviews, the Proposed GEIS concludes that "all plants" would experience the same impacts. *See id.*

But the Proposed GEIS fails to identify the impact of the no-action alternative on offsite land use as an issue. That is, the Proposed GEIS requires no analysis of the impact on land values in the vicinity of a nuclear facility if a license renewal application were denied. This analysis should be required. The impact of all types of power plants on property values has been established in peer-reviewed journals. *See, e.g., The Effect of Electric Utility Power Plant Location on Area Property Value*, Blomquist, G., *Land Economics*, Vol. 50, No. 1 (Feb. 1974) at 97-100. After adjusting for other factors, including property size and the demographic composition of the neighborhood, Blomquist found "a clear and statistically significant impact" of electric generating facilities on property values. *See Potential Impacts of Indian Point Relicensing on Property Values*, Stephen C. Sheppard, Ph.D. (Williams College, Economics) (2007) at 2 (attached as Ex. E) (ML073400193)("Sheppard Report").

A subsequent study determined that the impact on property values of nuclear power plants was, if anything, "larger" than the impact of fossil-fueled facilities *Id.* at 3 (*citing An Interregional Hedonic Analysis of Noxious Facility Impacts on Local Wages and Property Values*, Clark, D., and Nieves, L., *Journal of Environmental Economics and Management*, Vol. 27 (1994) at 235-253). Using data covering the entire country, and evaluating the impacts of 21 nuclear power plants, 39 coal-fired, and 53 gas- or oil-fired generating facilities, Clark and Nieves found impacts to offsite land uses "to a reasonable and professional accepted degree of scientific certainty from all types of power plant," and that the impact from nuclear generating facilities "is more than 3 times the impact of coal fired plants and more than 4 times the impact of gas and oil fired generating facilities." Sheppard Report at 3.[6]

The Proposed GEIS also improperly assumes that all impacts on offsite land use of an operating power plant are positive. *See generally* Proposed GEIS § 3.8 (socioeconomics) (nuclear facilities contribute to stable communities, provide jobs, employees occupy high cost housing, and facilities contribute to tax base). Conversely, the Proposed GEIS improperly assumes that virtually all impacts on offsite land use of the termination of operations would be negative. *See, e.g., id.* 4-204 - 4-205 (socioeconomic impacts of termination would be bad with possible exception of impacts on traffic); *id.* at 4-192 (predicting that termination would result in loss of property tax revenue). As set forth in the Sheppard Report, and published literature, however, this is error. Indeed, the Proposed GEIS itself acknowledges that license termination would eliminate cooling tower drift, effluent discharges, and radionuclide emissions. Proposed GEIS at 4-199. Similarly, license termination would end cooling water withdrawals and discharges, thus improving any nearby aquatic communities. *See id.* at 4-199 - 4-201. Inexplicably, however, the Proposed GEIS does not predict the potential impact on land use values of these important hedonic factors (nor does it require applicants to analyze them).

A license renewal applicant must analyze all potential impacts of the no-action alternative on offsite land use and must specifically address the impact of non-renewal on nearby property values. The kind of analysis necessary to determine the impact on surrounding real property of license renewal or non-renewal could not be done generically but would, instead, depend upon a site-specific analysis. Plainly, the impact of a facility in a rural area would be different than one in a semi-urban area, a fact the Proposed GEIS acknowledges. *See* Proposed GEIS at S-14 (changes

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[6] Unlike other studies, Clark and Nieves properly separated the impacts of the plants themselves from the employment or income-generating impacts of power plants. "This must be done to isolate the pure impact of the power plant that would be observed if the facility is completely replaced with an alternative use that is also capable of generating employment and income." Sheppard Report at 3. By contrast, a subsequent study done by Clark and 3 others, including William Metz (*see* GEIS at 3-28, 3-29, 3-164), inappropriately combined the discrete impacts of (1) job accessibility with (2) disamenity and nuisance associated with proximity to a nuclear power plants. "Combining these two impacts would be an appropriate technique for estimating the impact of the nuclear power plant ONLY in the case where the counter-factual being evaluated was complete removal and abandonment of the land." Sheppard Report at 3 (emphasis omitted).

in plant operations would have a greater impact in rural than semi-urban neighborhoods); *id.* at 4-204 - 4-205 (comparing socioeconomic consequences of license termination of plants in semi-urban areas to those in rural areas).

> If the presence of the nuclear power generating plant has a significant impact on property values, then it logically follows that extending the license will have a significant impact on property values which in turn will affect land use by affecting the decisions made by thousands of property owners and developers. Whether this significant impact exists is a scientifically testable question.

Sheppard Report at 2. Because the Proposed GEIS ignores the need to analyze the full panoply of impacts of license renewal or non-renewal on adjacent land values, it improperly categorizes offsite land use impacts as Category 1. Because Category 1 issues must share a single significance level, offsite land use must be a Category 2 issue. *See* Proposed GEIS at 4-3 ("Category 2 issues are those that do not meet one or more of the criteria of Category 1 and for which, therefore, an additional plant-specific review is required"); *see id.* (category 1 issues must share a single significance level).

1. The Proposed GEIS Ignores The Impacts On Offsite Land Use Values Of Increased Onsite Treatment And Storage Of Spent Fuel

The proposed GEIS also ignores the impact on offsite property values of increasing amounts of stored spent fuel generated by a facility as to which an extended license is sought. The impact on surrounding property values is ignored even though the proposed GEIS acknowledges that onsite storage will be necessary and will exceed original design capacity.

The Waste Confidence Findings and their related regulations at 10 C.F.R. § 51.23, "leave[] the onsite storage of spent nuclear fuel during the term of plant operation as the only option at the time of license renewal . . . . Until a permanent high-level waste repository is operational, the spent nuclear fuel will be safely stored either onsite or at offsite interim storage facilities (NRC 2006)." Proposed GEIS at 1-7. "Given the delays in the opening of the repository [for spent nuclear fuel], it is likely that power plants would have to expand their spent fuel storage capacity beyond their original design" capacity. Proposed GEIS at 4-226. Moreover, "[t]he most significant irreversible and irretrievable commitment of resources related to nuclear power plant operations during the license renewal term would be . . . the land used to dispose of wastes, including the spent nuclear fuel generated during the license renewal term." Proposed GEIS at 4-231.

The Proposed GEIS itself thus acknowledges that some facilities will indefinitely continue to store spent nuclear fuel onsite during and after any license renewal term. *See also* Proposed GEIS at 4-165 - 4-168. Yet the Proposed GEIS does not require license renewal applicants to analyze the site-specific offsite land use impacts of this increased onsite storage. *See id.* This omission is inconsistent with the Proposed GEIS's concession that "[u]navoidable adverse impacts would vary among plants and would depend on the specific characteristics of each plant and its interaction with the environment. These unavoidable adverse impacts would need to be evaluated in plant-specific SEISs." Proposed GEIS at 4-228. Indeed, the Proposed GEIS acknowledges that the storage issues at each facility will differ, *see id.* at 4-166 ("interim storage needs vary among the plants, with older units likely to lose pool storage capacity sooner than new ones"), yet nonetheless concludes that "the issue remains a Category 1 issue," *id.* at 4-168.

Minimally, license renewal applicants must analyze the impact on offsite land uses, including property values, of the increased and indefinite storage of spent nuclear fuel generated during the license renewal term. Applicants should address the impacts to property values in the areas surrounding the stored spent fuel, whether the spent fuel is stored in spent fuel pools or in onsite dry cask storage areas. This critical issue cannot be overlooked and cannot be analyzed generically. The Waste Confidence Rule does not relieve license renewal applicants of the need to analyze the impact on offsite land use of the undisputed increase in the indefinite storage of spent nuclear fuel at facilities located in a wide variety of settings (where impacts can be expected to differ greatly).

2. The Proposed GEIS Improperly Determines That Offsite Land Use Impacts Are "Small"

Finally, the Proposed GEIS also improperly determines that offsite land use impacts would be uniformly "small." *See* Proposed GEIS at S-6, 2-6 (Table 2.1-1), 4-6.

> The NRC's standard of significance for impacts uses the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27), which requires consideration of both "context" and "intensity." The NRC used the CEQ terminology to establish three significance levels: small, moderate, and large. The definitions of the three significance levels, which are presented in the footnotes to Table B-1 of 10 C.F.R. Part 51, Subpart A, Appendix B, follow:
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> - Small impact: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts do not

exceed permissible level in the Commission's regulations are considered small.

- Moderate impact: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

- Large impact: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Proposed GEIS at S-4 - S-5.

Again, however, the Proposed GEIS focuses only on the impacts of plant-related population changes and tax revenue changes. *Id.* at 4-7 ("The NRC has not identified any information or situations, including low population areas or population and tax revenue changes resulting from license renewal that would alter the conclusion that impacts would be small for all nuclear power plants"). But "there is clear scientific evidence that the presence of nuclear generating plants can reduce the value of property in the area around the plant." *Potential Impacts of Indian Point Relicensing on Property Values*, Stephen C. Sheppard, Ph.D. (Williams College, Economics) (2007) at 4. And, although there are differences in properly done studies "about how far the impact might extend, and about the magnitude of the impact," all properly done studies, "indicate the potential for a significant, not a small, impact." *Id.* Indeed, the Proposed GEIS itself acknowledges the possibility of a significant offsite land use impact. Describing a land use study done and relied upon for the 1996 GEIS, the Proposed GEIS describes impacts that were "small at two sites, moderate at four sites, and significant at one site depending on the local jurisdiction's ability to provide the public services necessary to support substantial industrial development." *Id.* at 3-29. Offsite land use "impacts at the Wolf Creek plant in Kansas were determined to be potentially significant if the plant was shut down." *Id.* The looming property tax crisis was averted. *See* Proposed GEIS at 3-29. But the fact that the crisis was averted does not alter the fact that the Wolf Creek facility had a significant impact on offsite land use. And it does not matter that the "significant" impact was not ultimately adverse.

The Proposed GEIS's decision to characterize all potential impacts on offsite land use as "small" is unsupported by both the relevant scientific studies and the proposed GEIS itself. *See Impacts of Indian Point Relicensing on Property Values* at 2-4 (electric generating facilities have a clear and statistically significant impact on residential property values, particularly on properties within a 2 mile radius) (Sheppard, S. C., 2007); *see also* Proposed GEIS at 3-29 (case study of land use changes in host communities indicated that potential impacts included moderate and significant impacts). As the ASLB in the Indian Point relicensing proceeding properly found, a license renewal applicant must "consider[] the impact on real estate values that would be caused by license renewal or non-renewal." Order, *Matter of Entergy Nuclear Operations, Inc.* at 82-83 (Indian Point Nuclear Generating Units 2 and 3) (ASLBP No. 07-858-03-LR-BD01) (Jul. 31, 2008) at 83.

E. The GEIS Fails to Properly Classify Broader Spent Fuel Pool Impacts As Class 2 Issues

Although the proposed GEIS does add analysis of radionuclides released to groundwater as a Class 2 issue which the State of New York supports (see Point A above), it continues to classify the on-site storage of spent nuclear fuel during the license renewal term as a Class 1 issue. On-site storage of spent nuclear fuel during the license renewal term should be classified as a class 2 issue because (1) new information which came to light after the 1996 GEIS shows that the spent fuel stored in a pool can catch fire, either by accident or due to sabotage, and release significant amounts of radiation to the surrounding area resulting in site-specific impacts, and (2) NRC has mitigated the impacts of the risks of such storage on a site-specific basis.[7]

1. NEPA and the Atomic Energy Act Require the NRC to Examine New Information Which Shows Increased Risk of Spent Fuel Pool Fires Which Could Have Site-Specific Impacts

NEPA and the Atomic Energy Act ("AEA") obligate the NRC to examine, in this GEIS, the site-specific environmental and safety impacts of spent fuel pools, taking into account new information. That new information, detailed below, shows clearly that the risk of spent fuel pool fire is greater than contemplated in the 1996 GEIS and that it deserves site-specific analysis.

a. NUREG-1738 and SECY 01-0100

In early 2001, five years after NRC issued its 1996 GEIS, it issued a technical study called NUREG-1738 that examined the risk posed by a spent-fuel pool zirconium fire. *See* U.S. Nuclear Reg. Comm'n, NUREG-1738, Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants, ML010430066 (2001)("NUREG-1738"). That study found that, if a spent-fuel pool

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[7] The Second Circuit recently addressed this issue in *State of New York v. United States Nuclear Reg. Comm'n*, 08-3903-ag(L), slip op. (2d Cir., Dec. 21, 2009). However, the NRC represented to the Second Circuit that the States would have an additional opportunity to raise their concerns regarding spent fuel pools during the comment period for the Proposed GEIS. *See* Brief of Federal Respondents, *State of New York v. United States Nuclear Reg. Comm'n*, 08-3903-ag(L) (Aug. 3, 2009), at 48.

lost enough water to uncover the spent-fuel assemblies, the spent fuel could heat to the point where the fuel's zirconium cladding might catch fire. *Id.* at 2-1 – 3-1, A1A-1 – A1A-6. Such a zirconium fire could generate a radioactive plume causing thousands of deaths from cancer. *Id.* at 1-12; NAT. ACAD. OF SCI., PUB. REP., SAFETY AND SECURITY OF COMMERCIAL SPENT NUCLEAR FUEL STORAGE, 49-50 (2006)("NAS Report"). Other studies submitted to NRC reached the same conclusion about the adverse consequences of a zirconium fire. Alvarez et al., *Reducing the Hazards from Stored Spent Power Fuel in the United States,* 11 SCI. & GLOBAL SEC. 1, 7-11 (2003)(and comment and response thereto)("Alvarez *et al.*, 'Reducing the Hazards'"); Beyea, Lyman & von Hippel, *Damages from a Major Release of Cs into the Atmosphere of the United States,* 12 SCI. & GLOBAL SEC. 125, 125-136 (2004).

Contrary to the generic treatment of spent-fuel pools in the 1996 GEIS, NUREG-1738 also found that "[h]eat removal is very sensitive to" plant-specific factors, including "fuel assembly geometry" and "rack configuration," and is "subject to unpredictable changes after an earthquake or cask drop that drains the pool." NUREG-1738 at x. It found further that "it was not feasible, without numerous constraints, to establish a generic decay heat level (and therefore a decay time) beyond which a zirconium fire is physically impossible." *Id.* It concluded that, "since a non-negligible decay heat source lasts many years and since configurations ensuring sufficient air flow for cooling cannot be assured, the possibility of reaching the zirconium ignition temperature cannot be precluded on a generic basis." *Id.* Following the release of NUREG-1738, NRC's Director of Operations issued a memorandum acknowledging that "a zirconium fire event can have public health and safety consequences similar to a severe core damage accident with a large offsite release" and "that the possibility of a zirconium fire cannot be dismissed even many years after final reactor shutdown." SECY-01-0100, Policy Issue (Notation Vote) (June 4, 2001) at 2, 5. He further acknowledged that NUREG-1738's findings differed from NRC's previous understanding that, if the water level in a pool dropped, then the spent fuel would be cooled by air and would never reach fire-ignition temperature. *Id.* at 2-3. Indeed, he stated that NRC staff had previously believed that "zirconium fire was not possible." *Id.* at 8. A report by NRC staff that was attached to that memorandum warned that sabotage could cause a drop in the level of water in a spent-fuel pool, contrary to the staff's prior belief that "sabotage could not cause a zirconium fire." *Id.* at 12-13. The report indicated that NRC had acknowledged the need to defend against the possibility of sabotage to spent-fuel pools, finding that even though the threat of sabotage could not be quantified, it "is likely in a range that warrants protection against a violent external assault as a matter of prudence." *Id.* at 7, 12. The report also suggested a regulatory change that would require a plant-specific review of security measures, thereby recognizing that the threat to spent-fuel pools could no longer be viewed as a generic issue. *Id.* at 16-17.

b. Robert Alvarez: Princeton University's Institute for Policy Studies

Similarly, a 2003 peer-reviewed article by Robert Alvarez, a Senior Scholar at Princeton University's Institute for Policy Studies and a former Senior Policy Advisor to the Secretary of Energy, that concluded that the dense packing of spent fuel in cooling pools does not provide a sufficient safety margin in the event of a pool breach and consequent water loss from an accident or terrorist attack. In such cases, the fuel most recently placed in the pool could heat up enough to ignite its zirconium cladding, possibly resulting in the release of large amounts of radioactivity to the environment. Alvarez *et al.*, "Reducing the Hazards" at 1-60. To reduce this risk, the Alvarez article recommended moving spent fuel that had cooled for five years to dry-cask storage. *Id.* at 27.

c. Congress and the National Academy of Sciences

Concerned about the implications of the Alvarez article and NUREG-1738, Congress directed NRC to seek independent technical advice from the National Academy of Sciences ("NAS") on the safety and security of spent-fuel storage. *See* H.R. REP. NO. 108-357, at 191 (2003)(Conf. Rep.). In response, the NAS confirmed the potential for a pool fire that could result in the release of a substantial portion of a fuel pool's radioactive inventory. NAS Report at 8. The NAS report also agreed with NUREG-1738 that the risk of spent-fuel pool fires cannot be determined on a generic basis: "[t]he potential vulnerabilities of spent fuel pools to terrorist attacks are plant-design specific. Therefore, specific vulnerabilities can be understood only by examining the characteristics of spent fuel storage at each plant." *Id.* Based on that study, Congress directed NRC to develop site-specific models to assess the risks of spent-fuel storage and the mitigation of those risks. H.R. REP. NO. 108-792, at 982 (2004)(Conf. Rep.). NRC proceeded with the analysis and mitigation measures. *Statement Submitted by the U.S. Nuclear Regulatory Commission to the Committee on Environment and Public Works Subcommittee On Clean Air, Climate Change, and Nuclear Safety, United States Senate Concerning NRC Oversight* (Mar. 9, 2006).

d. Gordon Thompson: Institute for Resource and Security Studies

A 2006 report by Gordon Thompson of the Institute for Resource and Security Studies concluded that increased storage of spent fuel in dry casks would allow lower-density packing of spent-fuel pools and decrease the risk of pool fires. *See* Gordon Thompson, Rep. for the Office of the Att. Gen. of Mass., Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants, 32 (2006) ("2006 Thompson Report").

e. Dr. Richard Lahey

In addition, attached to these Comments is an excerpt from a Declaration prepared by Dr. Richard T. Lahey, Jr. submitted in support of the State of New York's Notice of Intention to Participate and Petition to Intervene in *In re: License Renewal Application Submitted by Entergy Nuclear* (Indian Point Units 2 & 3) Docket Nos. 50-247-LR and 50-286-LR dated November 30, 2007 ("Declaration Excerpt")(Ex. F). Dr. Lahey is the *Edward E. Hood Professor Emeritus of Engineering* at Rensselaer Polytechnic Institute (RPI). He has served as the Dean of Engineering and Chairman of the Department of Nuclear Engineering & Science at RPI. He belongs to and has actively participated in a number of professional organizations including the American Nuclear Society, the American Society of Mechanical Engineers, the American Institute of Chemical Engineering and the American Society of Engineering Educators. He was the editor of the *Journal of Nuclear Engineering & Design.* He has served on numerous panels and committees for the NRC, Idaho National Engineering Laboratory, Oak Ridge National Laboratory, the Electric Power Research Institute and the National Research Council of the National Academies. Dr. Lahey was a member of the Committee on the Safety and Security of Commercial Spent Nuclear Fuel Storage which co-authored the National Research Council Report *Safety and Security of Commercial Spent Nuclear Fuel Storage* (Public Report 2006).[8]

In the attached Declaration Excerpt, Dr. Lahey identifies site specific mitigation measures, recommended in the *Safety and Security of Commercial Spent Nuclear Fuel Storage* Report, that should be, but have not been adopted for the Indian Point spent fuel pools to mitigate against the consequences of an external attack on the spent fuel pools. *See* Declaration Excerpt at ¶ 36. Dr. Lahey also identifies unique characteristics of the Indian Point plant configuration and location that require special measures to mitigate against the consequences of an external attack on the Indian Point spent fuel pools. *Id.* at ¶¶ 34, 35, 37 and 38.

Moreover, the risk to spent fuel pools is greater than acknowledged by the NRC. In the years since 9/11, the federal government has repeatedly acknowledged that there is a credible threat of intentional attacks on nuclear power plants, including the specific threat of an aircraft attack. *See, e.g.,* California Attorney General's Petition for Rulemaking to Amend 10 C.F.R. Part 51, In the Matter of Proposed Amendment to 10 C.F.R. Part 51, No. PRM-51-12, 8-9 (U.S. N.R.C. Mar. 21, 2007)("California Petition for Rulemaking"). In 2002, NRC itself issued an order requiring nuclear power plants "to develop specific guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities using existing or readily available resources (equipment and personnel)

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[8] Dr. Lahey's full curriculum vita is available at http://www.rpi.edu/~laheyr/.

that could be effectively implemented under the circumstances associated with loss of large areas of the plant due to explosions or fire, including those that an aircraft impact might create." *See* Letter from J. Boska, NRC, to M. Balduzzi, Entergy Nuclear Operations, ML071920023 (July 11, 2007). In 2003, a United States General Accounting Office report noted that the nation's commercial nuclear power plants are possible terrorist targets and criticized NRC's oversight and regulation of nuclear power plant security. *See* California Petition for Rulemaking at 10; *see also* GAO, Nuclear Power Plants Have Upgraded Security, but the NRC Needs to Improve Its Process for Revising the Design Basis Threat 1 (2006), *available at* http://www.gao.gov/new.items/ d06555t.pdf.

In 2005, prompted by concerns regarding the pace and substance of NRC's response to the threat of terrorist attacks on nuclear power plants, Congress required NRC to revise its "design basis threat" rule – which identifies the types of security threats that a nuclear power plant may face, 10 C.F.R. § 73.1(a), and the means by which a facility owner must be prepared to defeat such threats, *id.* § 73.55 – and, in that rulemaking process, to consider, among other things, "the events of September 11, 2001," "suicide attacks," "the potential for water-based and air-based threats," "the potential use of explosive devices of considerable size," and "large fires of long duration." 42 U.S.C. § 2210e(b)(1), (5)-(7) & (9). The NAS had also found that successful terrorist attacks on spent-fuel pools are possible and that under some conditions, a terrorist attack that partially or completely drained a spent-fuel pool could lead to a zirconium cladding fire that would "propagate" – *i.e.*, spread from the spent-fuel rod or assembly that initially caught fire to other assemblies – and cause the release of large quantities of radioactive materials to the environment. NAS Report at 38-39, 48. The NAS found further that the traditional risk analysis applied to industrial accidents – identifying an event, the probability the event will occur, and the consequences if that event were to occur – could not be applied to the risk of a terrorist attack because this risk depends on "impossible-to-quantify factors such as terrorist motivations, expertise, and access to technical means." *Id.* at 26. It recommended additional analyses to understand the events that could lead to zirconium fires. *Id.* at 58-59.

f. Sandia National Laboratories' 2006 Report

In a 2006 report, Sandia National Laboratories also identified site-specific variables, including pool design and configuration, fuel age and design, and building design and ventilation, that affect the rate at which spent fuel will heat up and become susceptible to fire if the water level in a pool drops. SANDIA Letter Report, Revision 2, *Mitigation of Spent Fuel Pool Loss-of-Coolant Inventory Accidents and Extension of Reference Plant Analyses to Other Spent Fuel Pools*, Sandia National Laboratories (Redacted by NRC and released on December 19, 2008) (ML090490559) at vii, 11-15. The report identified alternatives and mitigation measures to address high density storage of spent fuel in spent fuel pools at various facilities.

2. The NRC Has Mitigated the Risk from Spent Fuel Pools As Though They Were Category 2 Issues, But Has Failed to Disclose Those Impacts Arguing They Are Category 1 Issues

Moreover, NRC has mitigated the risks from spent fuel pools on a site-specific basis – that is, mitigating them like Category 2 issues – despite classifying them as Category 1 and failing to disclose the impacts and thus subject the NRC's mitigation measures to public comment as required by NEPA.

In 2008, the NRC denied a petition for rulemaking brought by California and Massachusetts which sought a rulemaking revising the GEIS and regulations on the grounds that mitigation measures the NRC had implemented at every plant had minimized the risk of a radiation release from a spent fuel pool. *See* NRC Rulemaking Denial (Aug. 1, 2008), 73 Fed. Reg. 46204 (Aug. 8, 2008). NRC's decision relied on recently implemented "mitigation measures" that would decrease the risk of a spent-fuel pool fire, but the only specific mitigation measure it discussed was a "coolant makeup and spray capability system" that would cool spent fuel in the event of a drop in the water level of a pool. NRC Rulemaking Denial at 22. It also stated that, "in cases where [spent fuel pool] water levels can not be maintained, leakage control strategies would be considered." *Id.* NRC indicated that it has issued license amendments and safety evaluations incorporating these strategies into all operating nuclear power plants, but the decision does not discuss the effectiveness of those measures or even the extent to which they are actually in use at plants.[9] *Id.* In fact, not all plants implemented the same mitigation measures, and some plants were not required to implement all of the recommended measures. *See* Safety Evaluation by The Office of Nuclear Reactor Regulation Related to Order No. Ea-02-026 Entergy Nuclear Operations, Inc. Indian Point Nuclear Generating Unit Nos. 2 and 3 Docket Nos. 50-247 and 50-286 (July 7, 2007) at pp. 1-4 (emphasis added) appended to a letter from NRC Staff to Entergy of the same date (ML071920020)(explaining that mitigating strategies related to the safety of the Indian Point Unit 2 spent fuel pool were not required due to being "screened out.").

In 1996, NRC found that the environmental impacts of spent-fuel pools could be considered generically. The 1996 generic EIS, and the regulations based on that

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[9] Despite the evidence submitted by the States showing that increased dry-cask storage would allow lower-density racking in spent fuel pools and thereby reduce the risk of fires in pools, NRC's discussion of mitigation measures did not mention that measure. *See* Alvarez *et al.*, "Reducing the Hazards" at 27, 2006 Thompson Report at 32, NAS Report at 68-71.

EIS, found that those impacts were not significant and designated them as Category 1 generic impacts on the ground that they did not require consideration of any plant-specific measures and would not be affected by any future mitigation measures. NUREG 1437 at 6-85 – 6-86. As a result, NRC does not consider those impacts in a plant-specific supplemental EIS when a plant's license is renewed. 10 C.F.R. § 51.53(c)(2).

But when the States asked NRC to reconsider its conclusion that the pools have no significant impacts, NRC relied on the existence of plant-specific measures. NRC cannot have it both ways: if, as NRC contends, measures that are plant-specific and were adopted since 1996 affect the environmental impacts of spent-fuel pools, then the impacts of spent-fuel pools should be treated as Category 2 plant-specific impacts and addressed in plant-specific EISs. NRC should remedy that inconsistency in this rulemaking.

NRC's administrative rulings confirm that it is treating the impacts of spent-fuel pools inconsistently. In *Massachusetts v. United States*, Massachusetts argued that NRC was required to consider new information regarding the environmental impacts of spent-fuel pools in proceedings to renew the licenses for the Pilgrim and Vermont Yankee nuclear power plants. 522 F.3d at 122-23. The First Circuit accepted NRC's claim that it was not required to consider that information in plant-specific license renewal proceedings, because the environmental impacts of spent-fuel pools are covered by NRC's 1996 generic EIS and regulations. *Id.* at 126-27. NRC argued, and the court agreed, that Massachusetts could challenge the generic EIS, and the regulations based on it, in a petition for a generic rulemaking. *Id.* at 127. But after avoiding a plant-specific environmental analysis of spent-fuel pools in the Pilgrim and Vermont Yankee licensing proceedings, NRC then relied on plant-specific security and mitigation measures to deny the States' request to modify the generic EIS and regulations. The security measures – *e.g.*, vehicle barriers, fences, and intrusion detection systems – and mitigation measures – coolant makeup and spray capability systems and leakage control strategies – on which NRC relied to deny the rulemaking petitions are necessarily plant-specific. Moreover, both NRC staff, in NUREG-1738, and the NAS found that the risk of a spent-fuel pool fire depends on plant-specific design factors, such as the configuration of the storage racks in a pool, and cannot be assessed on a generic basis. If, as NRC found in its decision here and NRC staff and the NAS have also found, plant-specific mitigation and security measures are relevant to the environmental impacts of spent-fuel pools, then those impacts are a Category 2 issue requiring analysis on a plant-specific basis when a plant's license is renewed. NRC's reliance on those plant-specific measures to deny the States' petitions is contrary to its own determination that the environmental impacts of spent-fuel pools are generic. It is also contrary to its determination in 1996 that those impacts would not be affected by any future mitigation measures.[10]

Indeed, by taking into account plant-specific measures, NRC has effectively revised its regulations – without the rulemaking process required by the Administrative Procedure Act, 5 U.S.C. § 553 – and redesignated the impacts as Category 2. NRC's determination that it can continue to treat the environmental impacts of spent-fuel pools as generic even though it admits that those impacts are affected by plant-specific issues precludes full consideration of those impacts, in violation of NEPA. For example, under NRC's reasoning, it will never have to consider the effectiveness of a particular plant's coolant makeup and spray capability system in preventing spent-fuel pool fires at that plant, even though NRC relied on that mitigation measure to make its generic no-impact determination. Where, as here, NRC's generic process does not resolve plant-specific concerns, NEPA requires it to consider those concerns in a plant-specific proceeding. *See Minnesota v. NRC*, 602 F.2d 412, 418 (D.C. Cir. 1979) ("The question is whether there has been an NRC disposition in generic proceedings that is adequate to dispose of the objections to the licensing amendments"). NRC's determination also prevents the public and other governmental bodies from receiving information about the plant-specific matters – design issues and security and mitigation measures – that affect the risk of fires in spent-fuel pools. That is contrary to NEPA's core purpose of ensuring that relevant information about the environmental consequences of an agency's action is made available to other governmental bodies and the public. *See Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989); *see also Dep't of Transp. v. Pub. Citizen,* 541 U.S. 752, 768-69 (2004); *Balt. Gas & Elec. Co.*, 462 U.S. at 97. It also conflicts with NEPA's goal of giving other government agencies "adequate notice of the expected consequences [of an agency's action] and the opportunity to plan and implement corrective measures in a timely manner." *See Robertson*, 490 U.S. at 350. The one-sided process employed by NRC precludes the States – which NRC expects to play a large role in responding to the environmental impacts of a spent-fuel pool fire – from meaningful participation in identifying and exploring those impacts. And it denies the States and the public the right to a hearing on those matters when a plant's license is renewed, in violation of the Atomic Energy Act. 42 U.S.C. § 2239(a)(1)(A).

In short, in light of NRC's own recognition that the risk of spent-fuel fires is affected by plant-specific issues and by measures that it has taken since it issued its 1996 generic EIS, NRC should reconsider its 1996 generic determination that spent-fuel pools have no significant environmental impacts, and change spent-fuel pool

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[10] To the extent that security concerns underlie the NRC's decision not to disclose the impacts or mitigation measures required to be disclosed by NEPA, this reason is without merit; the provisions of 10 C.F.R. section 2.900 *et. seq.* allow for consideration of such information in a secure proceeding.

impacts from a Category 1 to a Category 2 issue here.

F. The Proposed GEIS Contains an Inadequate Discussion of Seismic Issues

The Proposed GEIS contains a wholly inadequate discussion of seismic issues that could affect power reactors and associated systems, structures, and components, such as aging pipes, spent fuel pools, cooling structures, stacks, and concrete containment. Although the document spans 600 pages it contains only the most passing reference to seismic issues. Proposed GEIS at p. 3-50 (lines 15-25). This cursory reference contains no recognition that older plants and components were constructed before the advent of modern seismic building regulations nor does it recognize that seismic understanding and hazard analysis has expanded and improved over the last two decades.

The full extent of the Proposed GEIS's discussion of seismic issues follows:

> Nuclear power plants are constructed according to seismic specifications in 10 CFR Part 50, Appendix S. Their spent fuel pools are designed with reinforced concrete, allowing them to remain operable through the largest earthquake that has occurred or is expected to occur in the area. The U.S. Geological Survey (Frankel et al. 2005) mapped seismic hazards across the United States. In terms of the peak horizontal acceleration with a 10 percent probability of exceedance in 50 years, most nuclear power plants are located in seismically low-hazard areas, with peak accelerations of 0 to 8 percent of gravity. However, the two California plants – Diablo Canyon and San Onofre – are in locations with peak acceleration of 25 to 30 percent of gravity. These plants have been designed to safely withstand the seismic effects associated with earthquakes with epicenters at various locations and at various depths, magnitudes, and ground accelerations (AEC 1973; Southern California Edison 2007).

Id. The first two sentences also appear later in the document. *Id.* at 4-28 (lines 27-30).[11]

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[11] The USGS reference is to Frankel, A.D., M.D. Petersen, C.S. Mueller, K.M. Haller, R.L. Wheeler, E.V. Leyendecker, R.L. Wesson, S.C. Harmsen, C.H. Cramer, D.M. Perkins, and K.S. Rukstales. 2005. Scientific Investigations Map 2883, Seismic-Hazard Maps for the Conterminous United States. Proposed GEIS at p. 3-161

Indian Point Unit 1 and its systems, structures, and components – such as pipes, building walls and roofs, and cooling water, ventilation, and electric systems – were built at a time when there were no meaningful AEC seismic regulations and the understanding of regional seismic conditions was quite rudimentary. Although NRC revoked the operating license for the Indian Point Unit 1 power reactor in 1980, many of Unit 1's system, structures, and components were conjoined to Unit 2 and Unit 3 and are still in use today. These aging Unit 1 systems, structures, and components that were built to inferior seismic specifications, and Unit 2 and Unit 3's continued reliance on these systems today poses a significant safety question. Updated hazard assessments by the United States Geological Survey and a recent study published in the Bulletin Of The Seismological Society Of America that reports the discovery of a new and near-by seismic feature further underscore this safety concern.

The absence of any discussion or recognition that knowledge of intraplate and interplate seismicity has changed since the 1950s and 1960s when some the components and reactors were manufactures, installed, or constructed or that the most recent USGS seismic hazard analyses for existing reactor locations east of the Rocky Mountains reflects a higher hazard than that which was anticipated when those reactors were initially constructed and licensed constitutes a fundamental flaw in the environmental impact statement. This omission coupled with Staff's preference not to subject renewal applications to seismic reviews based on up-to-date seismic information impedes any contribution or participation by the public in this important aspect of the inquiry of whether or not to permit the facility to operate beyond its 40-year license. The minimalist mention of the issue in the Proposed GEIS makes it likely that the License Renewal Application itself, the associated Environmental Report, and Staff's site-specific EIS will not analyze the issue in any meaningful manner. This omission and the exclusion of analysis can be seen in the response to the Indian Point license renewal applications.[12]

(citing U.S. Geological Survey. Available URL: http://pubs. usgs.gov/sim/2005/2883/ (accessed October 3, 2007)). According to USGS, the referenced seismic hazard maps were published four years ago in 2005 and were based on work dating back to 2002 and earlier Frankel, A., Petersen, M., Mueller, C., Haller, K., Wheeler, R., Leyendecker, E.V., Wesson, R., Harmsen, S., Cramer, C., M.,Perkins, D., and Rukstales, K., 2002, Documentation for the 2002 Update of the National Seismic-Hazard Maps: *See* U.S. Geological Survey Open-File Report 02-420, 39 p. (http://pubs.usgs.gov/of/2002/ofr-02-420/).

[12] The probability of the occurrence of a severe seismic event is directly tied to the time period involved. Thus, by extending the license to operate a nuclear plant by an additional 20 years, the risk of a severe seismic event occurring during the operating life of the plant is increased by 50%, making the issue one that is appropriate for

Indian Point Unit 1 and its systems, structures, and components – such as pipes, building walls and roofs, and cooling water, ventilation, and electric systems – were built at a time when there were no meaningful AEC seismic regulations and the understanding of regional seismic conditions was quite rudimentary. Although NRC revoked the operating license for the Indian Point Unit 1 power reactor in 1980, many of Unit 1's system, structures, and components were conjoined to Unit 2 and Unit 3 and are still in use today. These aging Unit 1 systems, structures, and components that were built to inferior seismic specifications, and Unit 2 and Unit 3's continued reliance on these systems today poses a significant safety question. Updated hazard assessments by the United States Geological Survey and a recent study published in the Bulletin Of The Seismological Society Of America that reports the discovery of a new and near-by seismic feature further underscore this safety concern.

1. Seismic Concerns at Indian Point

As a result of data developed since the early 1980s (after the plants were constructed and received their operating licenses), the State of New York has concerns about the seismic risk posed by IP1, IP2, and IP3. IP1 was constructed during an era of relatively relaxed seismic guidelines. Indeed, Entergy recently acknowledged to NRC Staff that no seismic response spectra were prepared for IP1's construction. IP2 and IP3 were constructed to meet a design safe shutdown ground acceleration of only 0.15g.

USGS has developed a probabilistic seismic ground motion map for the New York Seismic Zone including the area around Indian Point. The contoured values which appear on the map reflect peak ground accelerations (PGA measured as % of the Earth's gravitational acceleration, g, for an exceedance probability of 2% in 50 years). The USGS tabulated PGA for the IP site is 0.19g. An excerpt of the USGS seismic map follows:

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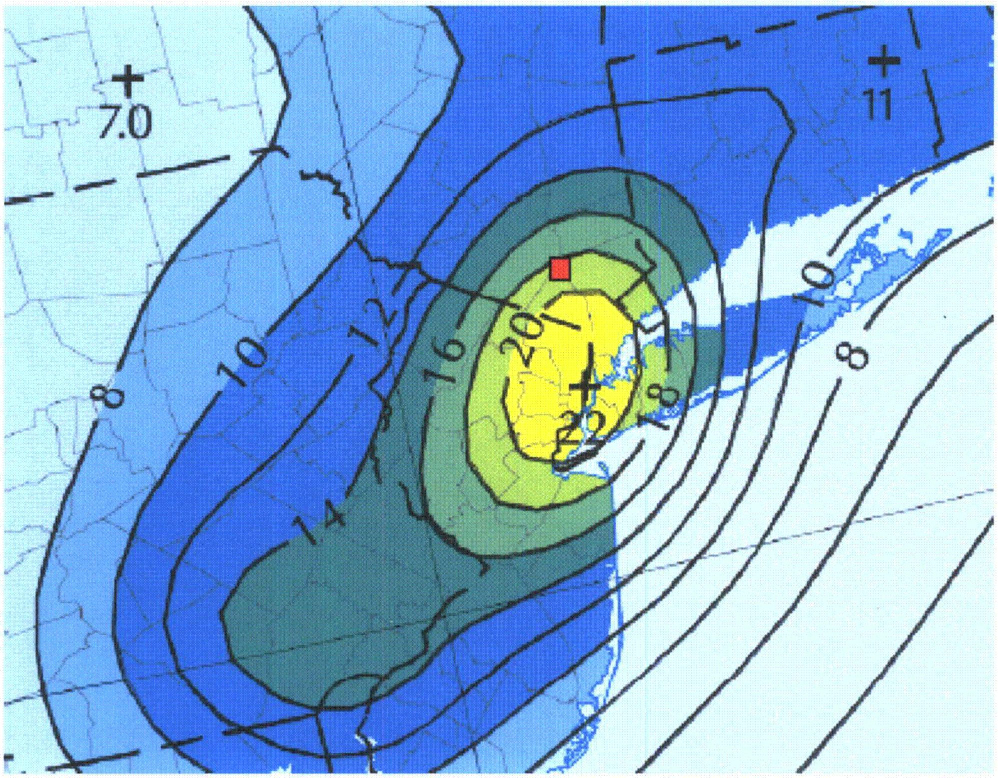
consideration in the license renewal proceeding.



Source: Portion of the USGS probabilistic seismic ground motion map for the region including the Indian Point site (red square).

Moreover, a recent seismic study has identified new information about a northwest-southeast oriented seismic feature running between Peekskill and Stamford that intersects the southwest-northeast oriented Ramapo Fault a few miles north of the Indian Point site. *See* Sykes, L.R., Armbruster, J.G., Kim, W., and Seeber, L., *Observations and Tectonic Setting of Historic and Instrumentally Located Earthquakes in the Greater New York City–Philadelphia Area*, BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA, Vol. 98, No. 4, pp. 1696–1719 (Aug. 2008) ("Observations and Tectonic Setting"). As stated by Dr. Lynn Sykes of Columbia University's Lamont-Doherty Earth Observatory, "Indian Point is situated at the intersection of the two most striking linear features marking earthquake activity in [the New York City Seismic Zone] and also in the midst of a large population that is at risk in case of an accident to the nuclear plants. This is clearly one of the least favorable sites on [the New York City Seismic Zone] from an earthquake perspective." November 29, 2007 Statement of Lynn R. Sykes, Ph.D. (Ex. G) (included in ML073400205) at 6. The August 2008 article reached a similar conclusion. *See* Observations and Tectonic Setting at 1717 ("This is clearly one of the least favorable sites in our study area from an earthquake hazard and risk perspective").

One particular area where there is a far greater understanding today is the difference between seismic activity at the plate margins and intraplate areas – directly relevant to the Indian Point location. Under the old paradigm, the area surrounding Indian Point was considered stable because it did not exhibit the type of geologic activity present at interplate margins such as the San Andreas Fault in California, which is known for frequent earthquakes with relatively short time periods between major quakes. In addition, the faults impacted by plate margin quakes often exhibit clear evidence of recent movement.

By contrast, intraplate areas are now known to have fairly frequent low magnitude earthquake activity, often concentrated in identifiable zones of weakness. But impacted faults typically show little or no visible evidence of recent activity at the earth's surface. Many large intraplate earthquakes worldwide are known to have very shallow depths. Data gathered subsequent to the initial permitting of Indian Point 2 and 3 clearly shows this type of intraplate earthquake activity (ranging in depths of 2 km to 15 km) in the vicinity of Indian Point. *See* Seborowski, K. D., G. Williams, J. A. Kelleher, and C. T. Statton, Tectonic implications of recent earthquakes near Annsville, New York, BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA 72, 1601-1609 (1982); Thurber, C. H., and T. C. Caruso, Crustal structure along the Ramapo fault zone, New York State, *Earthquake Notes* 56, 145-152 (1985); November 29, 2007 Statement of Leonardo Seeber (Ex. H) (included in ML073400205).

Another troubling aspect of the intraplate model of seismic activity, is the potential for earthquakes at depth, which may be of a larger magnitude than those seen in the recent past. The fact that they have not been seen but are still considered possible is because the time between these quakes can be dramatically longer than the relatively short period for which we have data. Given this possibility, it is imperative that the current data be included in a revised evaluation of seismic hazard using the intraplate model as well as applying recent developments in the field of earthquake engineering as part of the license renewal process.

Given this new information, the State has grave concerns about the continued use of any system, structure, and component associated with the aged and problem-plagued Indian Point Unit 1. Although the IP1 reactor ceased generating power over thirty years ago, as noted above, IP2 and IP3 continue to rely on various IP1 systems, structures, and components that the previous owner described as "integral" to the operation of IP2 and IP3. Reliance upon such systems, structures, and components is questionable given their age and the seismic fragility of IP1. Moreover, since the AEC gave IP1 a construction license in 1956, these IP1 systems, structures, and components could already have been subjected to fifty years of use.

As confirmed by a 1977 Atomic Licensing Appeal Board decision concerning Indian Point operating licenses, IP2 and IP3 were constructed to meet a design safe shutdown ground acceleration of 0.15g.[13] AEC approved the construction of IP1 before the promulgation of seismic regulations. As the same Atomic Licensing Appeal Board ruled in 1977: "This plant [Unit 1] was built prior to any specific requirement for earthquake protection and is not designed to withstand a 0.15g acceleration." 6 NRC at 585. In 1974, NRC Staff described the seismic construction of IP1 as follows:

> Unit 1 was designed on the basis of the seismic practices and codes existing in the mid-fifties, and, as a minimum, would be expected to withstand an earthquake having a ground acceleration of 0.1g without the occurrence of offsite exposures exceeding Part 100.

See Geologic and Seismic Evaluation of the Indian Point Site, at 1-6 (NRC Staff November 1974) PDR Accession No. 8110310762 741224. Indeed, Entergy recently admitted that:

> No response spectra were specifically generated for the Unit 1 site during original design.[14]

Following the cessation of power generation operation by the IP1 reactor in October 1974 and with the exception of the IP1 spent fuel pool, it is not clear whether or not any rigorous analysis of the seismic integrity of IP1's systems, structures, and components was ever conducted. Thus, all of the IP1 systems, structures, and components should be subjected to a transparent and rigorous seismic review.

Various IP1 structures, systems, and components, if damaged in an earthquake, could strike or damage components of IP2 and IP3, including but not

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[13] *In re Consolidated Edison Co.,* (Indian Point Units 1, 2 and 3), 6 NRC 547, 550 (ALAB 1977). This decision also confirms that IP1's seismic construction was built to "a lesser value" and that, as constructed, it could not sustain an acceleration of even 0.15g. 6 NRC at 550, 585. As noted, the safe shutdown value of 0.15 for IP2 and IP3 is less than the peak ground accelerations indicated on the more recent USGS seismic risk map.

[14] In a submission to NRC about a spent fuel crane, Entergy stated: "No responses spectra were specifically generated for the Unit 1 site during original design." *See* Entergy Reply to Request for Additional Information (RAI) Regarding Indian Point 1 License Amendment Request for Fuel Handling Building Crane, p. 12 of 24 (Oct. 3, 2007), Indian Point, Unit No.1, Docket No. 50-003, ML073050247.

limited to, the reactor containment, off-site power supplies, and spent fuel pools. The Unit 1 superheater stack, located on top of the IP1 Superheater Building is one example of such a structure. *See, e.g.,* IPEEE NUREG-1742, Vol. 2, p. 2-8 (identifying Unit 1 superheater stack as a seismic failure constituting a dominant risk contributor). The recent SER contains minimal and superficial analysis of seismic strength of IP1 turbine building & intake structure (2-212, 3-96 - 3-97). Checking a masonry wall in the intake structure is completely inadequate given the site's location, the age of the IP1 systems, structures, and components, and recent developments in seismology and the region's seismic profile. Given that the IP1 systems, structures, and components could be 50 years old, that they were designed, constructed, and installed when the knowledge of the area's seismic hazard was unformed, and that no response spectra were generated for IP1, all aspects of IP1 that support the continued operation of IP2 and IP3 should be examined.

The State also has concerns about the continued use of IP2 and IP3 given the development of knowledge of the region's seismic profile since the early 1980s. To begin with, NRC's Individual Plant Examination of External Events ("IPEEE") reflects an EPRI-derived Core Damage Factor ("CDF") for IP3 of 5.90E-05. *See* NUREG-1742, Vol. 2, Table 2-2. IP35 has the highest CDF of all the operating reactors listed in the slide. NUREG-1742, Vol. 2, Table 2.2. The Unit 1 superheater stack, located on top of the IP1 Superheater Building is one example of such a structure. *See, e.g.,* IPEEE NUREG-1742, Vol. 2, p. 2-8 (identifying Unit 1 superheater stack as a seismic failure constituting a dominant risk contributor). Furthermore, new engineering seismological findings, accumulating since the IP2 and IP3 received their operating licenses in the mid-1970s, include – but are not limited to – the following:

- Higher peak ground acceleration ("PGA") for the IP site (given by the USGS as 0.19g at a probability level commonly used for seismic building codes), compared to 0.1g used for the old OBE design, and 0.15g for SSE safety analyses of IP2/3. Stated differently, IP2 and IP3 were constructed to a design safe shutdown ground acceleration of only 0.15g, whereas the more recent USGS seismic risk map indicates a peak ground acceleration of 0.19g.

- A peak of 1.5 to 4 times higher response spectral amplitudes for seismic ground motions for the range of high frequencies ("HF") between 10 and 100 Hz compared to spectra used by the original OBE and SSE design. Despite assertions by Entergy that IP1/2/3 structures and components are not sensitive to such HF motions, its submitted UFSARs and other documents themselves clearly indicate that many Seismic Category 1 Structures at IP2/3 have their basic (and some higher-) mode responses in this high frequency range, and thus cannot be treated as if behaving rigidly. They are oscillating, subject to response amplifications at these high frequencies.

- Many modern seismic design aspects of ground motions were not considered in the old OBE and SSE designs for IP2/3. They include - but are not limited to: different ratios of Horizontal to Vertical ("H/V") ground motions as a function of frequency; incoherency of ground motions leading to torsional seismic loads not previously considered; and, to a lesser degree, actual geological bedrock conditions and how structures interact with these site conditions, essentially having been assumed as behaving seismically quasi-rigidly.

Despite these significant advances in seismic understanding, the Indian Point license renewal application relied on 30-year-old seismic data. Specifically, the so-called Updated Facility Safety Analysis Report expressly stated that its discussion of seismicity was based on data from 1980. This weakness extends throughout the application and includes the applicant's Environmental Report and the subsequent SEIS prepared by NRC Staff. Given the seismic fragility of other 50-year-old IP1 systems, structures, and components, and the new information concerning seismic hazards in the area that has been developed since IP2 and IP3 received their operating licenses in the mid-1970s, the State respectfully requests that the GEIS expressly direct applicants to:

- provide a thorough discussion of the facility's current seismic profile in the Environmental Report; and

- examine the facility's current seismic hazard through the Significant Accident Mitigation Alternative (SAMA) program that came about as a result of the Third Circuit's Limerick Ecology v. NRC decision.

In short, given the Commission's commitment to "protecting people and the environment," the Commission should insist on and welcome a searching inquiry in to seismic risks posed by the extended operation of each power reactor facility.

2. The Seismic Fragility of Indian Point Unit 1

It is imperative that the GEIS now under development acknowledge that older systems, structures and components should be subjected to close scrutiny with respect to seismic hazards and risks. Although the NRC approved the mothballing of the reactor in IP1, the Indian Point Unit 2 and Unit 3 continue to use various IP1 systems, structures, and components. Given the dates of the AEC construction and operating licenses, these IP1 systems, structures, and components may already have been in use for 47 to 53 years. As the following summary demonstrates, these interconnections with IP1 are extensive.

According to the 1980 decommissioning plan for the IP1 reactor, "Unit 1 contains *extensive common facilities that are required for the continued operation of Units 2 and 3.*" *See* Decommissioning Plan for Indian Point Unit 1, § 2.1 (Oct. 1980) (emphasis added). For example, the Indian Point Nuclear Power Station uses several IP1 systems, including without limitation: water supply, service boilers, electrical systems, integrated radwaste system, and nuclear steam generator blowdown purification system. *Id.* In 1988, ConEd told the NRC that Unit 1 "constitutes an *integral* part of power generating operations at the Indian Point site." *See* Supplemental Environmental Information in Support of Indian Point Unit No. 1, p. 2 (Mar. 1988)(emphasis added).

The August 2009 version of the Safety Evaluation Report ("SER") provides additional detail about the IP1 systems, structures, and components that are joined to and relied on by IP2 and IP3. For example, the IP1 Turbine Building, IP1 Intake Structure (also referred to as the IP Screenwell Building), IP1 Water Treatment Facility, the IP1 Superheater Building, the IP1 Nuclear Services Building remain in use and house systems and components necessary for the operation of IP2 and IP3 during the 20 year license renewal period. *See, e.g.,* SER 2-67, 2-75, 2-77 2-95, 2-104, 2-207 - 2-208. The SER also reveals that:

- The IP1 nuclear service building adjacent to but separated from the IP1 containment structure protects alternate safe shutdown system components in support of IP2. These components consist of cables in conduit for various systems: chemical and volume control, component cooling water, residual heat removal, and safety injection systems (2-211).

- IP2 shares IP1's central common control room and ventilation system (2-70). The common control room is located in the IP1 Superheater Building (2-208). And the tall IP1 superheater stack is located on top of the IP1 superheater building (2-211).

- IP1 compressed air systems & high capacity air compressors are used by IP2 (2-60). The air compressor system and the station air system includes the compressors, dryers, filters, receivers, distribution piping and valves, instruments, and controls. Items essential for safe operation and cooldown have air reserves or gas bottles that enable the equipment to function safely until its air supply resumes. The instrument air system includes piping, air bottles, valves, and controls supporting this air reserve function, but excludes the air or gas bottle parts of other systems. The system also may supply air to the post-accident venting system to pressurize containment in support of hydrogen control.

- The IP1 heating, ventilation, and air conditioning (HVAC) system is used by IP2 (2-65).

- The ignition oil tank and pump rooms are in the IP1 super-heater building (2-75).

- The IP2 fuel oil system includes the 1-million-gallon IP1 fuel oil tank and many of its associated components (2-90).

- IP2 and IP3 have a waste disposal system that send the liquid waste contents via pipe to the IP1 waste collection system (2-101).

- The nuclear service grade makeup system supplies water to various service systems. The system includes components of the IP1 water treatment facility (2-104).

- The city water system was originally installed for IP1, i.e., back in the late 1950s; the city water system now functions for all three units (2-96). IP2 and IP3 use city water to supply fire protection systems, the station blackout (SBO)/Appendix R diesel generator, sanitary and drinking facilities (e.g., emergency showers, eye wash stations, humidifiers, hose connections, sinks, etc.), radiation monitors for purging, and various equipment for makeup or cooling; to supply backup to the auxiliary feedwater pumps; and to serve other emergency purposes. The city water system contains safety-related components relied on to remain functional during and following design basis earthquakes. It also contains nonsafety-related components whose failure potentially could prevent the satisfactory accomplishment of a safety-related function. In addition, the city water system performs functions that support fire protection and SBO (2-96, 2-170).

- The IP2 SBO/Appendix R diesel is located inside the IP1 Turbine Building (2-95).

- IP2 relies on IP1 fire protection components (2-71) including the IP1 fire pumps and some associated IP1 fire protection components, such as hydrants, valves, fire extinguishers, and strainers.

- The IP1 Turbine Building houses the electric fire pump (2-67).

- The IP1 Screenwell Building/IP1 Intake Structure houses Hydrants 11 and 12, and the IP1 fuel oil tank farm has Hydrants 17 and 18 (2-77, 2-203).

- For a critical fire scenario, IP1 plays an important role, and the following IP1 systems and components would be called on: IP1 fresh water cooling; IP1 river water service; IP1 station air; IP1 water treatment plant; and IP1 auxiliary steam system components (2-115- 2-116).

- The IP3 fire protection system may depend on the IP1 fire protection system. IP3 underground piping has two connections with the IP1 fire protection system (2-151). Although Entergy states (3-88) that it does not rely on this cross-connection, it is not clear how IP3 does "not rely" on this actual physical link with IP1.

These systems, structures, and components were fabricated, constructed, and installed between 1956 and 1962. The State of New York submits that all such conjoined IP1 systems, structures, and components (*e.g.*, pipes, ducts, tanks, buildings, and structures) must be included within the scope of any safety and seismic review undertaken in connection of the appropriateness to renew the operating licenses for IP2 and IP3.

The recent experience in the Indian Point proceeding discussed above illustrate the weaknesses in NRC's current approach to the analysis of seismic risks at the license renewal stage. On a broader level, as NRC is aware, USGS has informed the Commission that reactor sites located in the central and eastern United States have a higher seismic hazard than previously recognized. NRC should take this opportunity to modify the proposed GEIS and revamp its approach to such hazards to ensure that a thorough and transparent review takes place at this important juncture.

V. Conclusion

The State of New York respectfully requests that the NRC consider the above comments before issuing a revised GEIS and proceeding to a final rulemaking.

Dated: January 12, 2010

Respectfully submitted,

s/

Janice A. Dean
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Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:11 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: GZA Report Indian Point [1] Figure 9.4 - Current Unit 1 Activity Isopleths.pdf

Due to unsuccessful attempts to email documents together, I will send them one by one. This may be a duplicate email. I attach 1 of 6 documents which will constitute Exhibit A to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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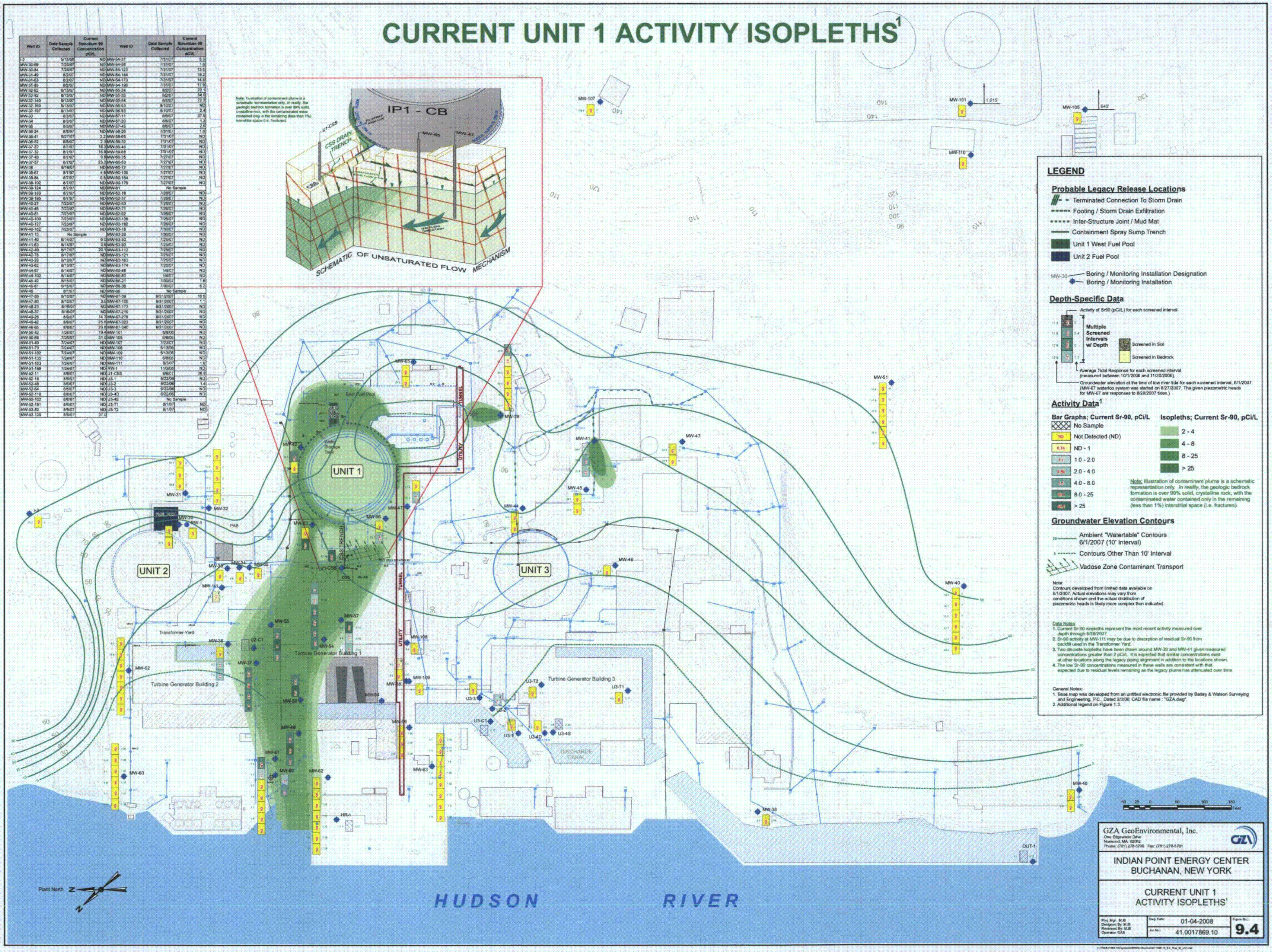
CURRENT UNIT 1 ACTIVITY ISOPLETHS[1]

Well ID	Date Sample Collected	Current Strontium 90 Concentration pCi/L	Well ID	Date Sample Collected	Current Strontium 90 Concentration pCi/L
I-2	5/13/08	ND	MW-54-37	7/31/07	5.3
MW-30-69	7/23/07	ND	MW-54-58	7/31/07	1.6
MW-30-84	7/25/07	ND	MW-54-123	7/31/07	13.5
MW-31-49	8/2/07	ND	MW-54-144	7/31/07	19.2
MW-31-63	8/2/07	ND	MW-54-173	7/31/07	14.5
MW-31-85	8/2/07	ND	MW-54-190	7/31/07	17.9
MW-32-62	8/13/07	ND	MW-55-24	8/2/07	23.1
MW-32-92	8/13/07	ND	MW-55-35	8/2/07	34.0
MW-32-140	8/13/07	ND	MW-55-54	8/2/07	22.3
MW-32-160	8/13/07	ND	MW-56-53	8/10/07	ND
MW-32-197	8/13/07	ND	MW-56-83	8/10/07	2.4
MW-33	8/3/07	ND	MW-57-11	8/6/07	27.9
MW-34	8/3/07	ND	MW-57-20	8/6/07	1.2
MW-35	8/3/07	ND	MW-57-45	8/6/07	2.6
MW-36-24	8/8/07	ND	MW-58-26	7/31/07	1.0
MW-36-41	5/27/07	2.2	MW-58-65	7/31/07	ND
MW-36-52	8/8/07	2.3	MW-59-32	7/31/07	ND
MW-37-22	8/7/07	18.3	MW-59-45	7/31/07	ND
MW-37-32	8/7/07	16.9	MW-59-68	7/31/07	ND
MW-37-40	8/7/07	9.8	MW-60-35	7/27/07	ND
MW-37-57	8/7/07	23.3	MW-60-53	7/27/07	ND
MW-38	8/16/07	ND	MW-60-72	7/27/07	ND
MW-39-67	8/7/07	4.8	MW-60-135	7/27/07	ND
MW-39-84	8/7/07	0.8	MW-60-154	7/27/07	ND
MW-39-102	8/7/07	ND	MW-60-176	7/27/07	ND
MW-39-124	8/7/07	ND	MW-61	No Sample	
MW-39-183	8/7/07	ND	MW-62-18	7/26/07	ND
MW-39-195	8/7/07	ND	MW-62-37	7/26/07	ND
MW-40-27	7/23/07	ND	MW-62-53	7/26/07	ND
MW-40-46	7/23/07	ND	MW-62-71	7/26/07	ND
MW-40-81	7/23/07	ND	MW-62-92	7/26/07	ND
MW-40-100	7/23/07	ND	MW-62-138	7/26/07	ND
MW-40-127	7/23/07	ND	MW-62-182	7/26/07	ND
MW-40-162	7/23/07	ND	MW-63-18	7/30/07	ND
MW-41-13	No Sample		MW-63-29	7/30/07	ND
MW-41-40	8/14/07	6.0	MW-63-50	7/25/07	ND
MW-41-63	8/14/07	3.6	MW-63-93	7/25/07	ND
MW-42-49	8/17/07	20.1	MW-63-112	7/25/07	ND
MW-42-78	8/17/07	ND	MW-63-121	7/25/07	ND
MW-43-28	8/13/07	ND	MW-63-163	7/25/07	ND
MW-43-62	8/13/07	ND	MW-63-174	7/25/07	ND
MW-44-67	8/14/07	ND	MW-65-48	1/4/07	ND
MW-44-102	8/14/07	ND	MW-65-80	1/4/07	ND
MW-45-42	8/15/07	ND	MW-66-21	7/30/07	1.6
MW-45-61	8/15/07	ND	MW-66-36	7/30/07	6.2
MW-46	8/1/07	ND	MW-66	No Sample	
MW-47-56	8/10/07	ND	MW-67-39	8/31/2007	18.6
MW-47-80	8/10/07	3.6	MW-67-105	8/31/2007	1.1
MW-48-23	8/16/07	ND	MW-67-173	8/31/2007	ND
MW-48-37	8/16/07	ND	MW-67-219	8/31/2007	ND
MW-49-26	8/9/07	14.3	MW-67-276	8/31/2007	ND
MW-49-42	8/9/07	25.5	MW-67-323	8/31/2007	ND
MW-49-65	8/9/07	20.8	MW-67-340	8/31/2007	ND
MW-50-42	7/26/07	19.4	MW-101	6/8/06	ND
MW-50-66	7/26/07	31.0	MW-105	6/8/06	ND
MW-51-40	7/24/07	ND	MW-107	7/23/07	ND
MW-51-79	7/24/07	ND	MW-108	5/13/06	ND
MW-51-102	7/24/07	ND	MW-109	5/13/06	ND
MW-51-135	7/24/07	ND	MW-110	6/8/06	ND
MW-51-163	7/24/07	ND	MW-111	8/3/07	1.0
MW-51-189	7/24/07	ND	RW-1	11/3/06	ND
MW-52-11	8/6/07	ND	U1-CSS	8/8/07	36.8
MW-52-18	8/6/07	ND	U3-1	6/22/06	ND
MW-52-48	8/6/07	ND	U3-2	6/22/06	1.4
MW-52-64	8/6/07	ND	U3-3	6/22/06	ND
MW-52-118	8/6/07	ND	U3-4D	6/22/06	ND
MW-52-162	8/6/07	ND	U3-4S	No Sample	
MW-52-181	8/6/07	ND	U3-T1	8/1/07	ND
MW-53-82	8/6/07	ND	U3-T2	8/1/07	ND
MW-53-120	8/6/07	37.0			



GZA GeoEnvironmental, Inc.

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

CURRENT UNIT 1
ACTIVITY ISOPLETHS[1]

01-04-2008

41.0017869.10

9.4

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:12 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: GZA Report Indian Point [2] Figure 9.3 - Current Unit 2 Activity Isopleths.pdf

I attach the 2nd of 6 documents which will constitute Exhibit A to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

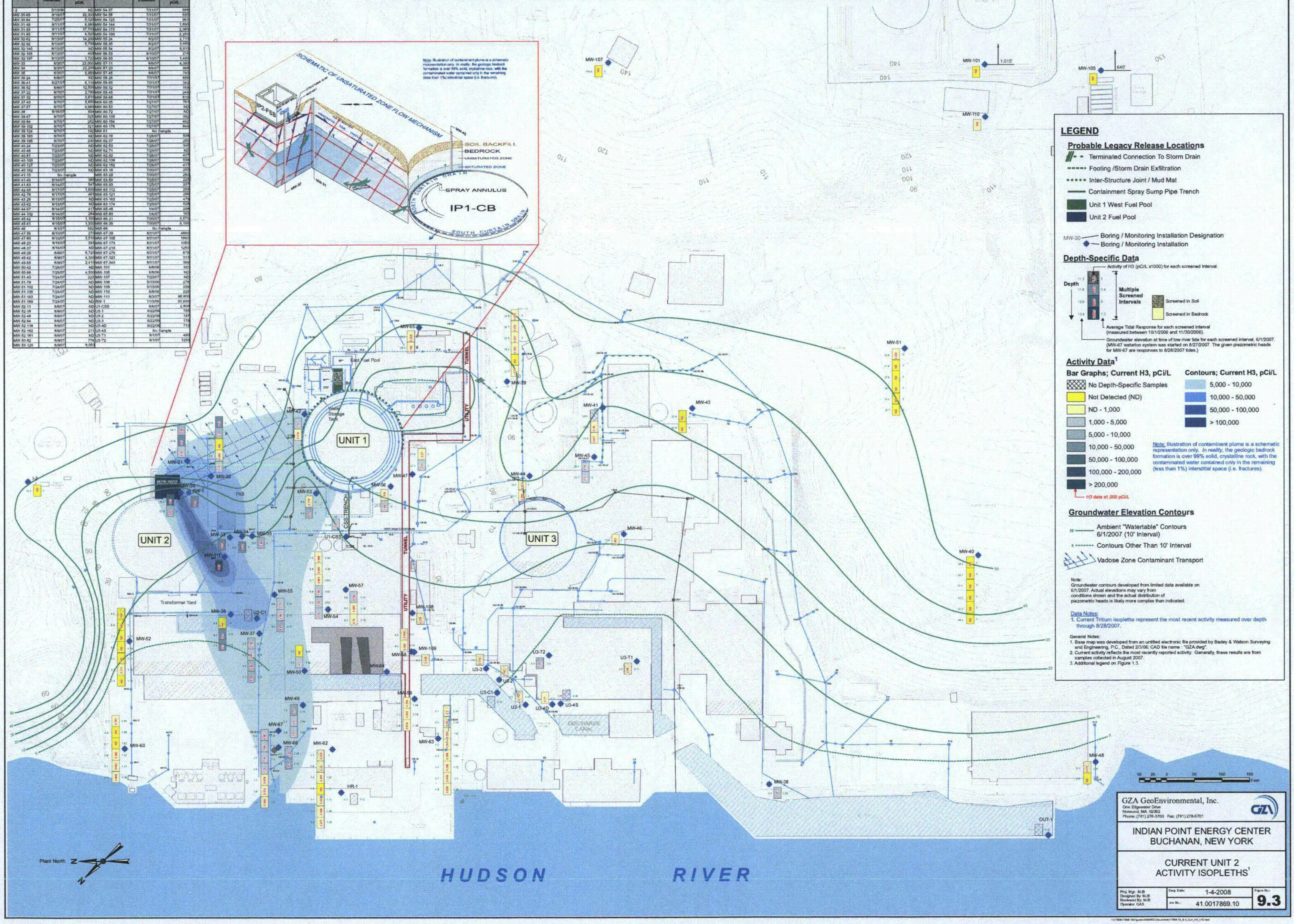
Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
Environmental Protection Bureau
Office of the New York State Attorney General
120 Broadway, 26th Floor
New York, NY 10271
(212) 416-8459 (voice)
(212) 416-6007 (fax)
Please note new email address:
janice.dean@ag.ny.gov

CURRENT UNIT 2 ACTIVITY ISOPLETHS[1]

Well ID	Date Sample Collected	Current Tritium Concentration pCi/L	Well ID	Date Sample Collected	Current Tritium Concentration pCi/L
-2	5/13/06	ND	MW-54-37	7/31/07	888
MW-30-69	9/19/07	92,000	MW-54-58	7/31/07	693
MW-30-84	7/25/07	5,020	MW-54-123	7/31/07	963
MW-31-49	9/11/07	6,980	MW-54-144	7/31/07	1,690
MW-31-63	9/11/07	37,700	MW-54-173	7/31/07	2,080
MW-31-85	9/11/07	4,320	MW-54-190	7/31/07	2,250
MW-32-62	8/13/07	14,200	MW-55-24	8/2/07	2,710
MW-32-92	8/13/07	5,700	MW-55-35	8/2/07	3,680
MW-32-140	8/13/07	ND	MW-55-54	8/2/07	9,910
MW-32-165	8/13/07	493	MW-56-53	8/10/07	216
MW-32-187	8/13/07	1,720	MW-56-83	8/10/07	1,490
MW-33	8/3/07	23,000	MW-57-11	8/6/07	4,093
MW-34	8/3/07	22,200	MW-57-20	8/6/07	965
MW-35	8/3/07	5,980	MW-57-45	8/6/07	740
MW-36-24	8/8/07	ND	MW-58-26	7/31/07	656
MW-36-41	6/27/07	6,110	MW-58-65	7/31/07	342
MW-36-52	8/8/07	12,500	MW-59-32	7/31/07	169
MW-37-22	8/7/07	2,790	MW-59-45	7/31/07	249
MW-37-32	8/7/07	3,810	MW-59-68	7/31/07	819
MW-37-40	8/7/07	5,850	MW-60-35	7/27/07	761
MW-37-57	8/7/07	6,680	MW-60-53	7/27/07	ND
MW-38	8/16/07	604	MW-60-72	7/27/07	ND
MW-39-67	8/7/07	325	MW-60-135	7/27/07	392
MW-39-84	8/7/07	252	MW-60-154	7/27/07	462
MW-39-102	8/7/07	321	MW-60-176	7/27/07	849
MW-39-124	8/7/07	192	MW-61	No Sample	
MW-39-183	8/7/07	ND	MW-62-18	7/26/07	508
MW-39-195	8/7/07	200	MW-62-37	7/26/07	250
MW-40-24	7/23/07	ND	MW-62-53	7/26/07	345
MW-40-46	7/23/07	ND	MW-62-71	7/26/07	ND
MW-40-81	7/23/07	ND	MW-62-92	7/26/07	437
MW-40-100	7/23/07	ND	MW-62-138	7/26/07	538
MW-40-127	7/23/07	ND	MW-62-182	7/26/07	417
MW-40-162	7/23/07	ND	MW-63-18	7/30/07	200
MW-41-13	No Sample		MW-63-29	7/30/07	280
MW-41-40	8/14/07	380	MW-63-50	7/25/07	225
MW-41-63	8/14/07	547	MW-63-93	7/25/07	237
MW-42-49	8/17/07	1,600	MW-63-112	7/25/07	288
MW-42-78	8/17/07	461	MW-63-121	7/25/07	296
MW-43-28	8/13/07	ND	MW-63-163	7/25/07	479
MW-43-62	8/13/07	ND	MW-63-174	7/25/07	528
MW-44-67	8/14/07	417	MW-65-48	1/4/07	208
MW-44-102	8/14/07	284	MW-65-80	1/4/07	163
MW-45-42	8/15/07	1,160	MW-66-21	7/30/07	3,670
MW-45-61	8/15/07	1,500	MW-66-38	7/30/07	9,100
MW-46	8/1/07	882	MW-66	No Sample	
MW-47-56	8/10/07	270	MW-67-39	8/31/07	4860
MW-47-80	8/10/07	3,510	MW-67-105	8/31/07	1980
MW-48-23	8/16/07	393	MW-67-173	8/31/07	1050
MW-48-37	8/16/07	ND	MW-67-219	8/31/07	1250
MW-49-26	8/9/07	8,720	MW-67-276	8/31/07	679
MW-49-42	8/9/07	4,300	MW-67-323	8/31/07	313
MW-49-65	8/9/07	2,410	MW-67-340	8/31/07	369
MW-50-42	7/26/07	ND	MW-101	6/8/06	ND
MW-50-66	7/26/07	4,500	MW-105	6/8/06	ND
MW-51-40	7/24/07	223	MW-107	7/23/07	ND
MW-51-79	7/24/07	ND	MW-108	5/13/06	278
MW-51-102	7/24/07	ND	MW-109	5/13/06	339
MW-51-135	7/24/07	ND	MW-110	6/8/06	225
MW-51-163	7/24/07	ND	MW-111	8/3/07	98,800
MW-51-189	7/24/07	ND	RW-1	11/3/06	30,600
MW-52-11	8/6/07	ND	U1-CSS	8/6/07	2,800
MW-52-18	8/6/07	ND	U3-1	6/22/06	755
MW-52-48	8/6/07	ND	U3-2	6/22/06	197
MW-52-84	8/6/07	ND	U3-3	6/22/06	179
MW-52-118	8/6/07	ND	U3-4D	6/22/06	710
MW-52-162	8/6/07	211	U3-4S	No Sample	
MW-52-181	8/6/07	ND	U3-T1	8/1/07	490
MW-53-82	8/9/07	776	U3-T2	8/1/07	1250
MW-53-120	8/9/07	8,050			



Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:12 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: GZA Report Indian Point [3] Figure 9.2 - Unit 1 Strontium Plume Cross Section B-B.pdf

I attach the 3rd of 6 documents which will constitute Exhibit A to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

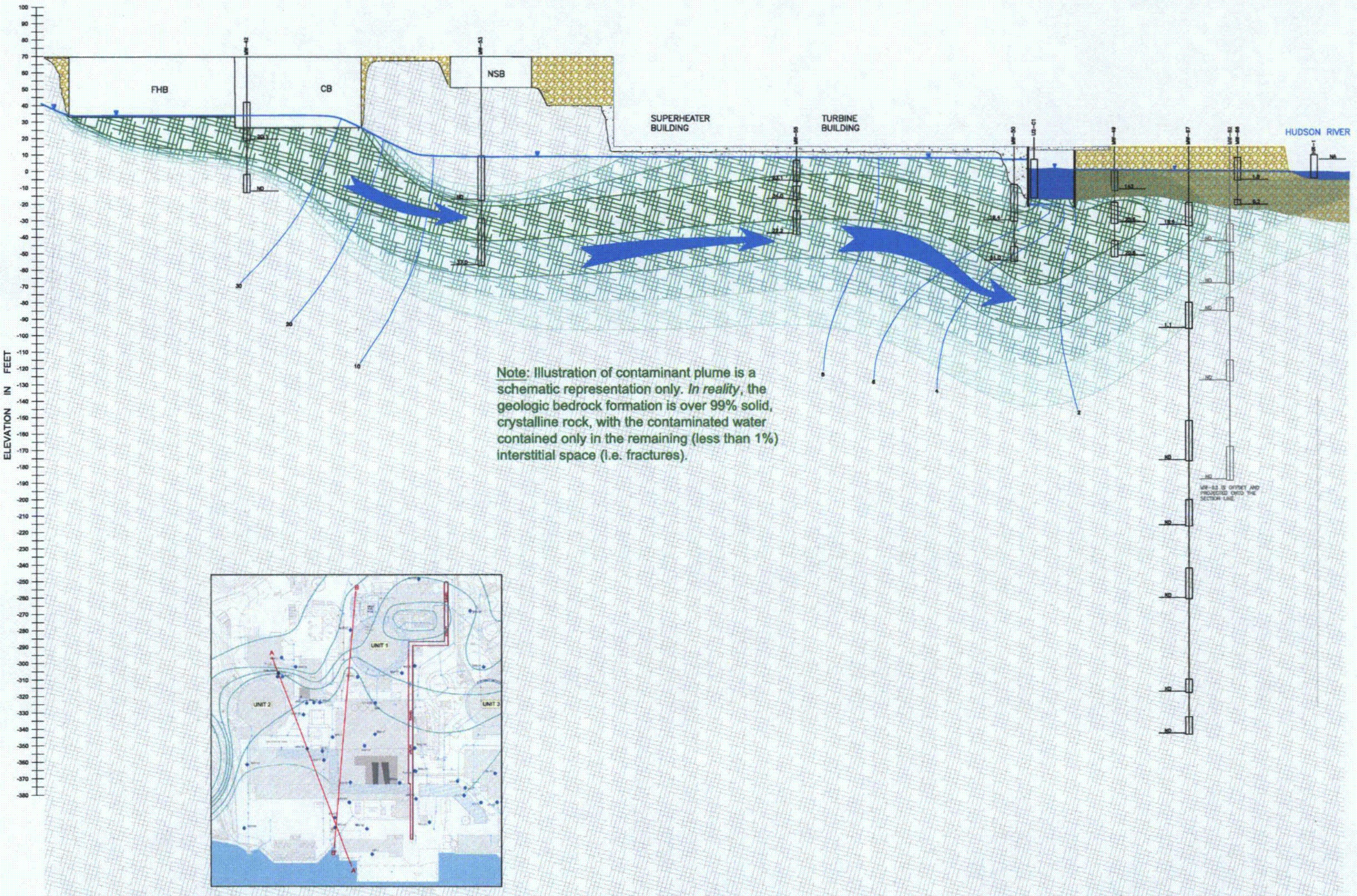
Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
Environmental Protection Bureau
Office of the New York State Attorney General
120 Broadway, 26th Floor
New York, NY 10271
(212) 416-8459 (voice)
(212) 416-6007 (fax)
Please note new email address:
janice.dean@ag.ny.gov

CROSS SECTION B-B'



CROSS SECTION LOCATION - FROM FIGURE 6.17

LEGEND:

- CONCRETE
- OVERBURDEN
- BEDROCK
- GROUNDWATER PIEZOMETRIC HEAD CONTOUR
- GROUNDWATER TABLE
- GROUNDWATER FLOW DIRECTION
- MONITORING WELL
- SCREENED INTERVAL
- 8.6 MEASURED ACTIVITY OF SR-90 (pCi/L) FOR EACH SCREENED INTERVAL

CONTOUR INTERVAL

SOIL ROCK

- 2-4 pCi/L
- 4-8 pCi/L
- 8-25 pCi/L
- >25 pCi/L

MOST RECENT MEASURED ACTIVITIES IN pCi/L THROUGH AUGUST 2007 DATA.

NOTES:

1. BASE MAP DEVELOPED FROM ELECTRONIC FILES, PREPARED BY BADEY AND WATSON SURVEYING & ENGINEERING PC, COLD SPRING, NY 10516. EXACT LOCATIONS AND ORIENTATIONS OF STRUCTURES ABOVE THE WATER TABLE ARE APPROXIMATE AND/OR HAVE BEEN MODIFIED ON THESE SECTIONS TO BETTER ILLUSTRATE CONTAMINANT SOURCE MECHANISMS AND/OR MIGRATION PATHWAYS.
2. WATER LEVEL READINGS HAVE BEEN MADE IN THE MONITORING WELLS,AT THE TIMES AND UNDER THE CONDITIONS STATED. THESE DATA HAVE BEEN REVIEWED AND INTERPRETATIONS MADE IN THE TEXT OF THIS REPORT. HOWEVER, IT MUST BE STATED THAT FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO VARIATIONS IN RAINFALL, TIDES, TEMPERATURE AND OTHER FACTORS.
3. THE STRATIFICATION LINES ARE BASED UPON INTERPOLATIONS BETWEEN WIDELY SPACED BORINGS, AND MONITORING WELLS AND THUS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES. ACTUAL TRANSITIONS MAY VARY FROM THOSE SHOWN.
4. MW-62 IS OFFSET AND PROJECTED ONTO THE SECTION LINE.
5. SEE FIGURE 6.17 FOR CROSS SECTION LOCATION

REV. NO.	DESCRIPTION	BY	DATE

SCALE: 1" = 30 FEET

GZA GeoEnvironmental, Inc.
440 NINTH AVENUE
NEW YORK, NY 10001
PH.: (212) 594-8140
FAX: (212) 279-8180

PROJ MGR: DMW
DESIGNED BY: MJG
REVIEWED BY: DMW/MJB
OPERATOR: CJF/GAS/CRB
DATE: 01-04-2008

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

UNIT 1 STRONTIUM PLUME CROSS SECTION B-B'

PROJECT NO. 17869.10

FIGURE NO. 9.2

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:12 PM
To: Janice Dean; Rulemaking Comments
Cc: John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: GZA Report Indian Point [4] Figure 9.1 - Unit 2 Tritium Plum Cross Section A-A.pdf

I attach the 4th of 6 documents which will constitute Exhibit A to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

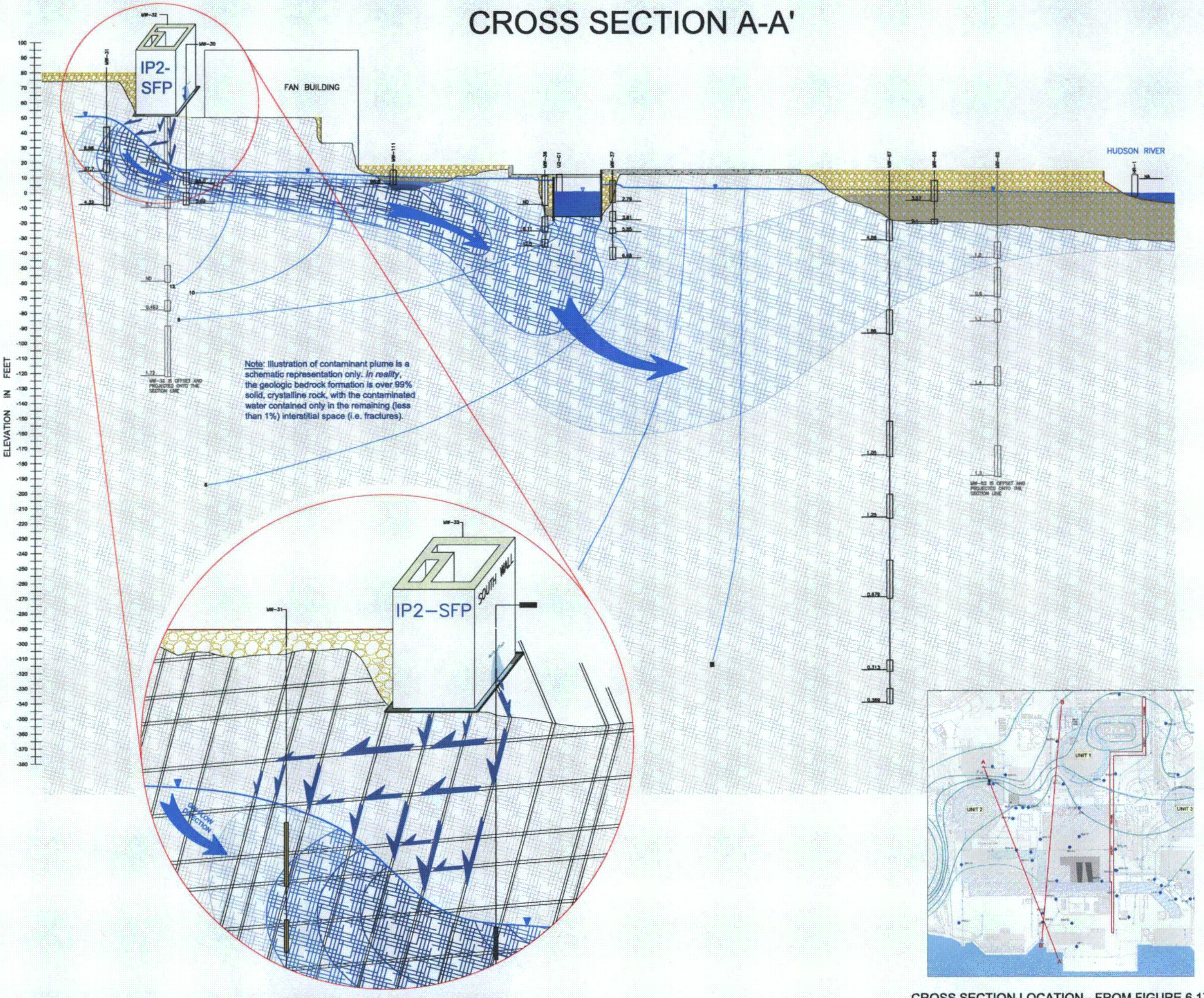
Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
Environmental Protection Bureau
Office of the New York State Attorney General
120 Broadway, 26th Floor
New York, NY 10271
(212) 416-8459 (voice)
(212) 416-6007 (fax)
Please note new email address:
janice.dean@ag.ny.gov

CROSS SECTION A-A'



UNSATURATED ZONE FLOW MECHANISM

LEGEND:

- CONCRETE
- OVERBURDEN
- BEDROCK
- GROUNDWATER PIEZOMETRIC HEAD CONTOUR
- GROUNDWATER TABLE
- GROUNDWATER FLOW
- UNSATURATED ZONE FLOW DIRECTION
- MUD MAT
- MONITORING WELL
- SCREENED INTERVAL
- 1.25 MEASURED ACTIVITY OF H3 (pCi/L X 1,000) FOR EACH SCREENED INTERVAL AUG./SEPT. 2007.

CONTOUR INTERVAL

SOIL	ROCK	
		5,000 – 10,000
		10,000 – 50,000
		50,000 – 100,000
		> 100,000

MOST RECENT MEASURED ACTIVITIES IN pCi/L THROUGH AUGUST 2007 DATA

NOTES:

1. BASE MAP DEVELOPED FROM ELECTRONIC FILES, PREPARED BY BADEY AND WATSON SURVEYING & ENGINEERING PC, COLD SPRING, NY 10516. EXACT LOCATIONS AND ORIENTATIONS OF STRUCTURES ABOVE THE WATER TABLE ARE APPROXIMATE AND/OR HAVE BEEN MODIFIED ON THESE SECTIONS TO BETTER ILLUSTRATE CONTAMINANT SOURCE MECHANISMS AND/OR MIGRATION PATHWAYS.
2. WATER LEVEL READINGS HAVE BEEN MADE IN THE MONITORING WELLS,AT THE TIMES AND UNDER THE CONDITIONS STATED. THESE DATA HAVE BEEN REVIEWED AND INTERPRETATIONS MADE IN THE TEXT OF THIS REPORT. HOWEVER, IT MUST BE STATED THAT FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO VARIATIONS IN RAINFALL, TIDES, TEMPERATURE AND OTHER FACTORS.
3. THE STRATIFICATION LINES ARE BASED UPON INTERPOLATIONS BETWEEN WIDELY SPACED BORINGS, AND MONITORING WELLS AND THUS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES. ACTUAL TRANSITIONS MAY VARY FROM THOSE SHOWN.
4. MW–32 AND MW–62 ARE OFFSET AND PROJECTED ONTO THE SECTION LINE.
5. SEE FIGURE 6.17 FOR CROSS SECTION LOCATION.

CROSS SECTION LOCATION - FROM FIGURE 6.17

REV. NO.	DESCRIPTION	BY	DATE

SCALE: 1" = 30 FEET

GZA GeoEnvironmental, Inc.
440 NINTH AVENUE
NEW YORK, NY 10001
PH.: (212) 594–8140
FAX: (212) 279–8180

PROJ MGR: DMW
DESIGNED BY: MJG
REVIEWED BY: DMW/MJB
OPERATOR: CJF/GAS/CRB
DATE: 01–04–2008

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

UNIT 2 TRITIUM PLUME
CROSS SECTION A–A'

PROJECT NO. 17869.10

FIGURE NO. 9.1

Mendiola, Doris

From:	Janice Dean [Janice.Dean@ag.ny.gov]
Sent:	Tuesday, January 12, 2010 1:13 PM
To:	Rulemaking Comments
Cc:	Janice Dean; John Sipos; Teresa Fountain
Subject:	Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments:	GZA Report Indian Point [5] Figure 6.9 - Fracture Profile Projections.pdf

I attach the 5th of 6 documents which will constitute Exhibit A to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:11 PM >>>
Due to unsuccessful attempts to email documents together, I will send them one by one. This may be a duplicate email. I attach 1 of 6 documents which will constitute Exhibit A to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

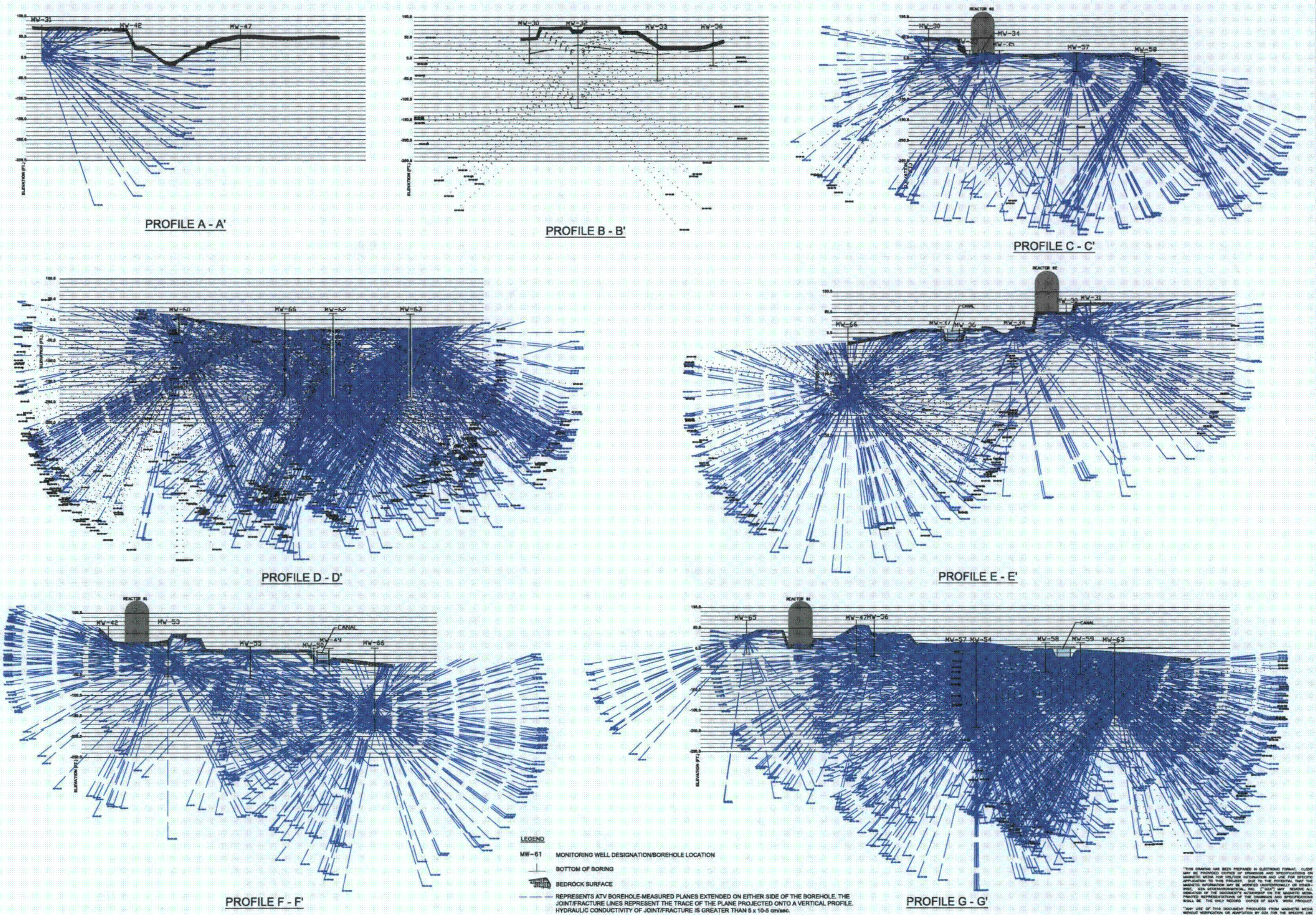
>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
Environmental Protection Bureau
Office of the New York State Attorney General
120 Broadway, 26th Floor
New York, NY 10271
(212) 416-8459 (voice)
(212) 416-6007 (fax)
Please note new email address:
janice.dean@ag.ny.gov



LEGEND

MW-61	MONITORING WELL DESIGNATION/BOREHOLE LOCATION
⊥	BOTTOM OF BORING
	BEDROCK SURFACE
— — —	REPRESENTS ATV BOREHOLE-MEASURED PLANES EXTENDED ON EITHER SIDE OF THE BOREHOLE. THE JOINT/FRACTURE LINES REPRESENT THE TRACE OF THE PLANE PROJECTED ONTO A VERTICAL PROFILE. HYDRAULIC CONDUCTIVITY OF JOINT/FRACTURE IS GREATER THAN 5 x 10-5 cm/sec.
· · · · ·	REPRESENTS ATV BOREHOLE-MEASURED PLANES EXTENDED ON EITHER SIDE OF THE BOREHOLE. THE JOINT/FRACTURE LINES REPRESENT THE TRACE OF THE PLANE PROJECTED ONTO A VERTICAL PROFILE. HYDRAULIC CONDUCTIVITY OF JOINT/FRACTURE IS LESS THAN 5 x 10-5 cm/sec.

NOTE: REFER TO FIGURE NO. 6.8 FOR PROFILE LOCATIONS.

REV. NO.	DESCRIPTION	BY	DATE

SCALE IN FEET: 0, 50', 100', 200'

GZA GeoEnvironmental, Inc.
ONE EDGEWATER DRIVE
NORWOOD, MA 02062
PH.: (781) 278-3700
FAX: (781) 278-5701

PROJ MGR: DMW
DESIGNED BY: DMW
REVIEWED BY: DMW
OPERATOR: GAS/EMD
DATE: 01-04-2008

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

FRACTURE PROFILE PROJECTIONS

PROJECT NO. 17869.10

FIGURE NO. 6.9

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:14 PM
To: Janice Dean; Rulemaking Comments
Cc: John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: GZA Report Indian Point [6] Figure 6.13 - Fracture Strike Orientation At Elevation 10.pdf

I attach the 6th of 6 documents which constitute Exhibit A to the State's comments. Exhibits B through H will follow via separate emails.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
Environmental Protection Bureau
Office of the New York State Attorney General
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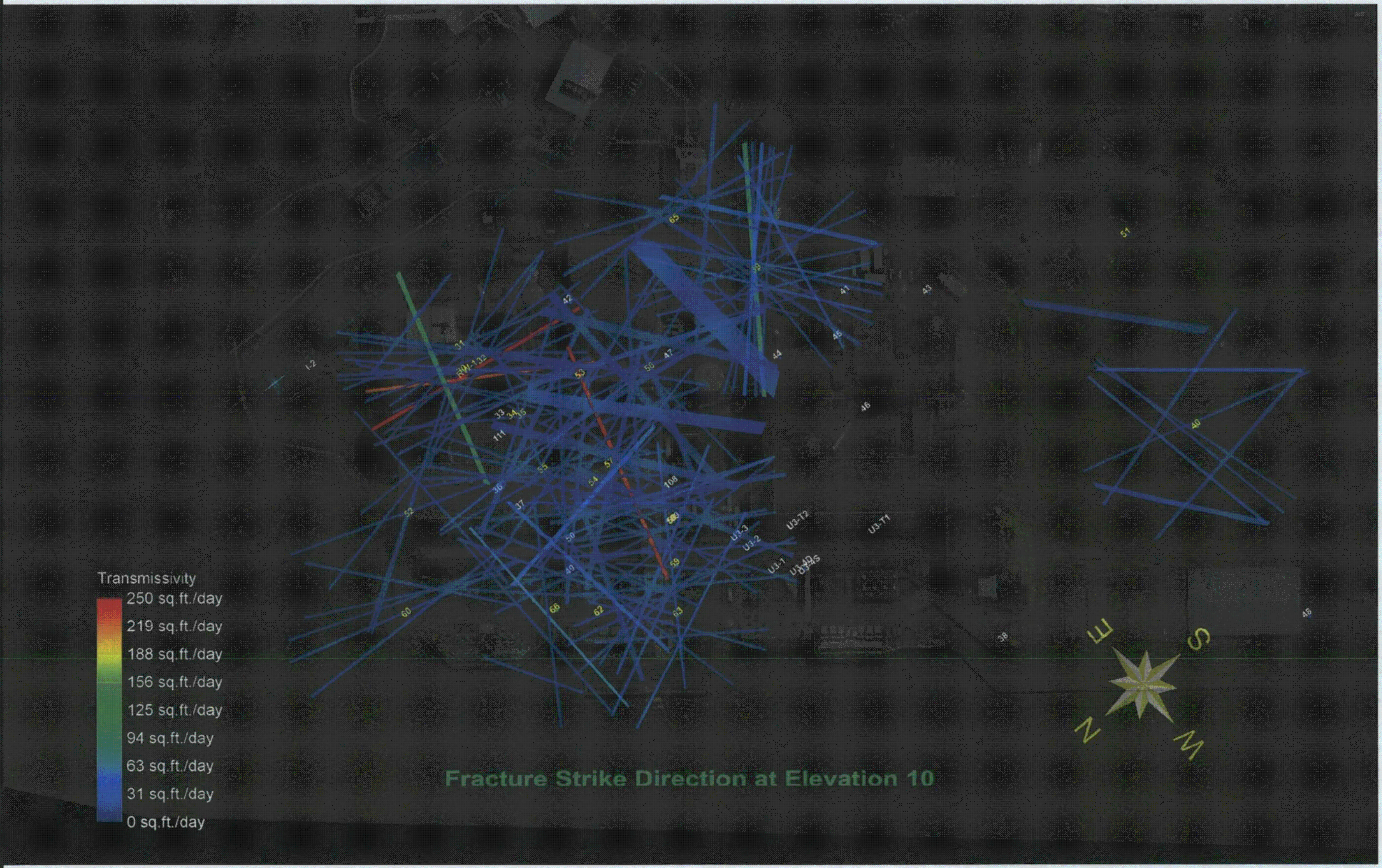
New York, NY 10271
(212) 416-8459 (voice)
(212) 416-6007 (fax)
Please note new email address:
janice.dean@ag.ny.gov



GZA-J:\17,000-18,999\17869\17869-10.DW\Figures\November-2007-Report\17869-10_strike_lines_el_10.dwg [FIG_6-13] January 04, 2008 - 4:28am Elaine.Donohue

JOB NO. 17869.10	INDIAN POINT ENERGY CENTER BUCHANAN, NEW YORK	PROJ MGR: MJB DESIGNED BY: JDR REVIEWED BY: MJB OPERATOR: JDR
FIGURE NO. 6.13	FRACTURE STRIKE ORIENTATION AT ELEVATION 10	DATE: 08-06-2007

GZA GeoEnvironmental, Inc.
ONE EDGEWATER DRIVE
NORWOOD, MA 02062
Ph.: (781) 278-3700
Fax: (781) 278-5701

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:05 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: GZA Report Indian Point [7] Figure 6.14 - Fracture Strike Orientation At Elevation-100.pdf; GZA Report Indian Point [4] Figure 9.1 - Unit 2 Tritium Plum Cross Section A-A.pdf; GZA Report Indian Point [5] Figure 6.9 - Fracture Profile Projections.pdf; GZA Report Indian Point [6] Figure 6.13 - Fracture Strike Orientation At Elevation 10.pdf

Attached please find the remaining documents for Exhibit A to the State of New York's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
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Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
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(212) 416-8459 (voice)
(212) 416-6007 (fax)
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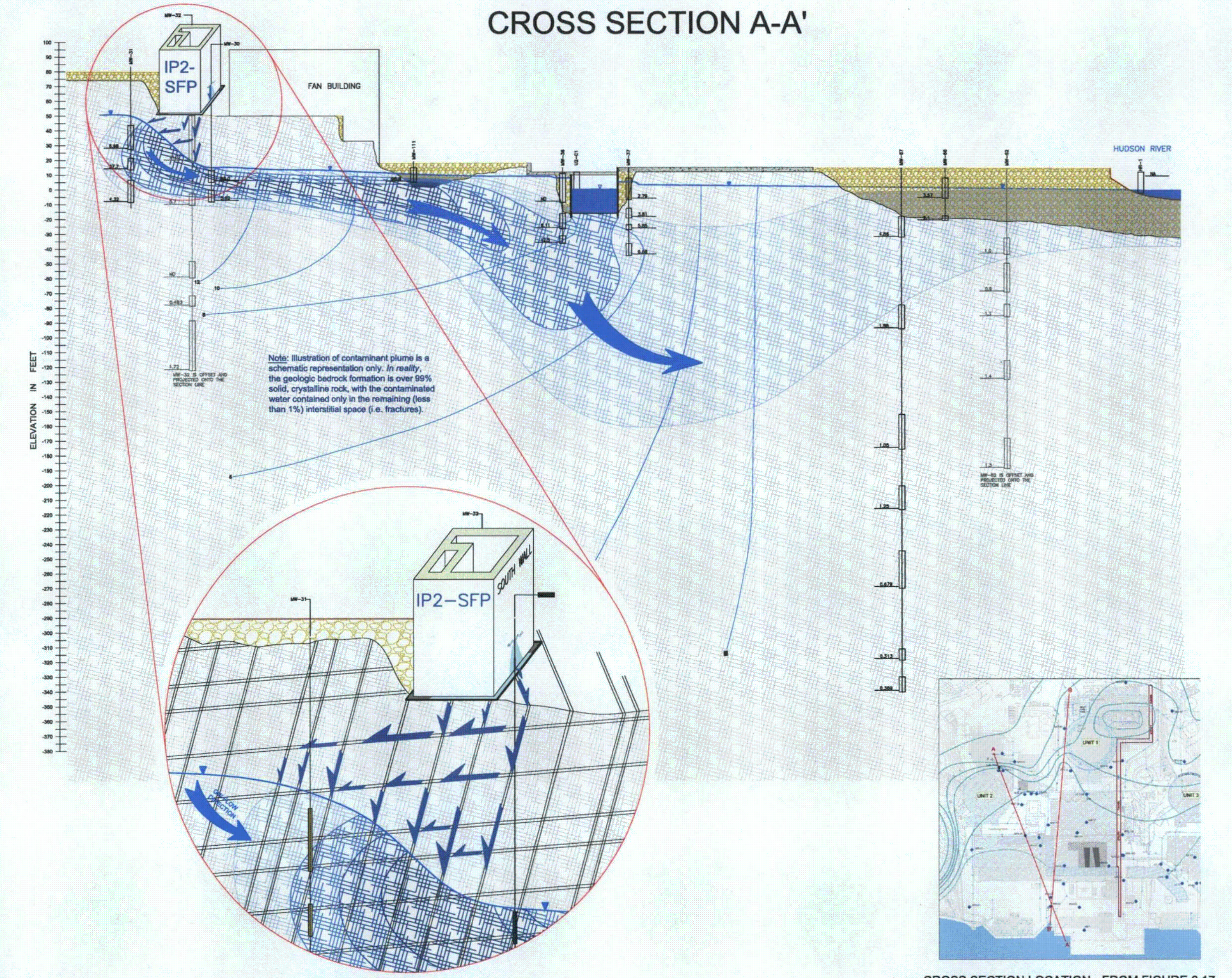
janice.dean@ag.ny.gov

CROSS SECTION A-A'



UNSATURATED ZONE FLOW MECHANISM

CROSS SECTION LOCATION - FROM FIGURE 6.17

LEGEND:

- CONCRETE
- OVERBURDEN
- BEDROCK
- GROUNDWATER PIEZOMETRIC HEAD CONTOUR
- GROUNDWATER TABLE
- GROUNDWATER FLOW
- UNSATURATED ZONE FLOW DIRECTION
- MUD MAT
- MONITORING WELL
- SCREENED INTERVAL
- 1.25 MEASURED ACTIVITY OF H3 (pCi/L X 1,000) FOR EACH SCREENED INTERVAL AUG./SEPT. 2007.

CONTOUR INTERVAL

SOIL ROCK

- 5,000 – 10,000
- 10,000 – 50,000
- 50,000 – 100,000
- > 100,000

MOST RECENT MEASURED ACTIVITIES IN pCi/L THROUGH AUGUST 2007 DATA

NOTES:

1. BASE MAP DEVELOPED FROM ELECTRONIC FILES, PREPARED BY BADEY AND WATSON SURVEYING & ENGINEERING PC, COLD SPRING, NY 10516. EXACT LOCATIONS AND ORIENTATIONS OF STRUCTURES ABOVE THE WATER TABLE ARE APPROXIMATE AND/OR HAVE BEEN MODIFIED ON THESE SECTIONS TO BETTER ILLUSTRATE CONTAMINANT SOURCE MECHANISMS AND/OR MIGRATION PATHWAYS.
2. WATER LEVEL READINGS HAVE BEEN MADE IN THE MONITORING WELLS,AT THE TIMES AND UNDER THE CONDITIONS STATED. THESE DATA HAVE BEEN REVIEWED AND INTERPRETATIONS MADE IN THE TEXT OF THIS REPORT. HOWEVER, IT MUST BE STATED THAT FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO VARIATIONS IN RAINFALL, TIDES, TEMPERATURE AND OTHER FACTORS.
3. THE STRATIFICATION LINES ARE BASED UPON INTERPOLATIONS BETWEEN WIDELY SPACED BORINGS, AND MONITORING WELLS AND THUS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES. ACTUAL TRANSITIONS MAY VARY FROM THOSE SHOWN.
4. MW-32 AND MW-62 ARE OFFSET AND PROJECTED ONTO THE SECTION LINE.
5. SEE FIGURE 6.17 FOR CROSS SECTION LOCATION.

REV. NO.	DESCRIPTION	BY	DATE

SCALE: 1" = 30 FEET

GZA GeoEnvironmental, Inc.
440 NINTH AVENUE
NEW YORK, NY 10001
PH.: (212) 594-8140
FAX: (212) 279-8180

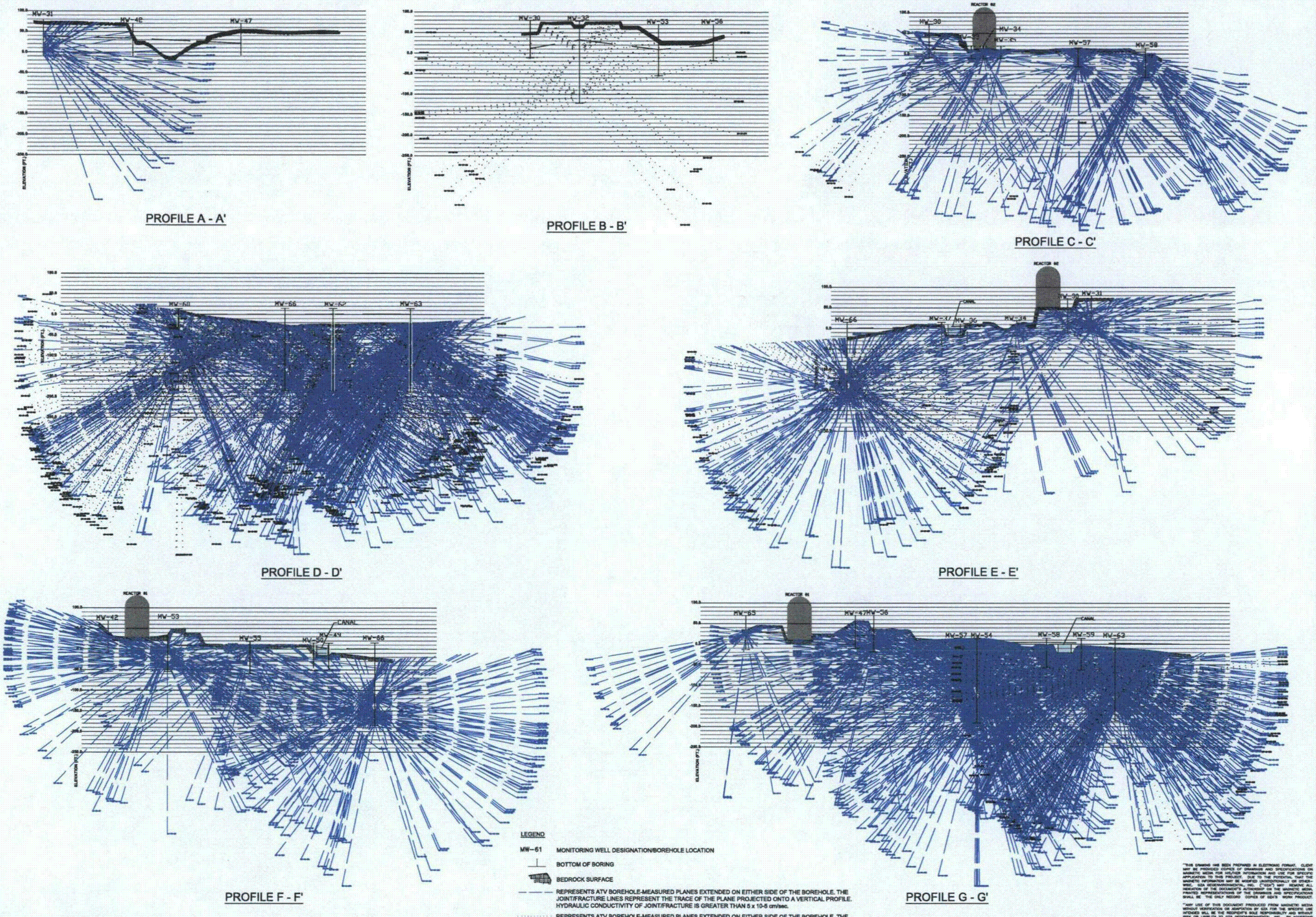
PROJ MGR: DMW
DESIGNED BY: MJC
REVIEWED BY: DMW/MJB
OPERATOR: CJF/GAS/CRB
DATE: 01-04-2008

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

UNIT 2 TRITIUM PLUME
CROSS SECTION A-A'

PROJECT NO. 17869.10

FIGURE NO. 9.1



LEGEND

MW–61 MONITORING WELL DESIGNATION/BOREHOLE LOCATION

BOTTOM OF BORING

BEDROCK SURFACE

REPRESENTS ATV BOREHOLE-MEASURED PLANES EXTENDED ON EITHER SIDE OF THE BOREHOLE. THE JOINT/FRACTURE LINES REPRESENT THE TRACE OF THE PLANE PROJECTED ONTO A VERTICAL PROFILE. HYDRAULIC CONDUCTIVITY OF JOINT/FRACTURE IS GREATER THAN 5 x 10-5 cm/sec.

REPRESENTS ATV BOREHOLE-MEASURED PLANES EXTENDED ON EITHER SIDE OF THE BOREHOLE. THE JOINT/FRACTURE LINES REPRESENT THE TRACE OF THE PLANE PROJECTED ONTO A VERTICAL PROFILE. HYDRAULIC CONDUCTIVITY OF JOINT/FRACTURE IS LESS THAN 5 x 10-5 cm/sec.

NOTE: REFER TO FIGURE NO. 6.8 FOR PROFILE LOCATIONS.

REV. NO.	DESCRIPTION	BY	DATE

SCALE IN FEET: 0 50' 100' 200'

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ONE EDGEWATER DRIVE
NORWOOD, MA 02062
PH.: (781) 278-3700
FAX: (781) 278-5701

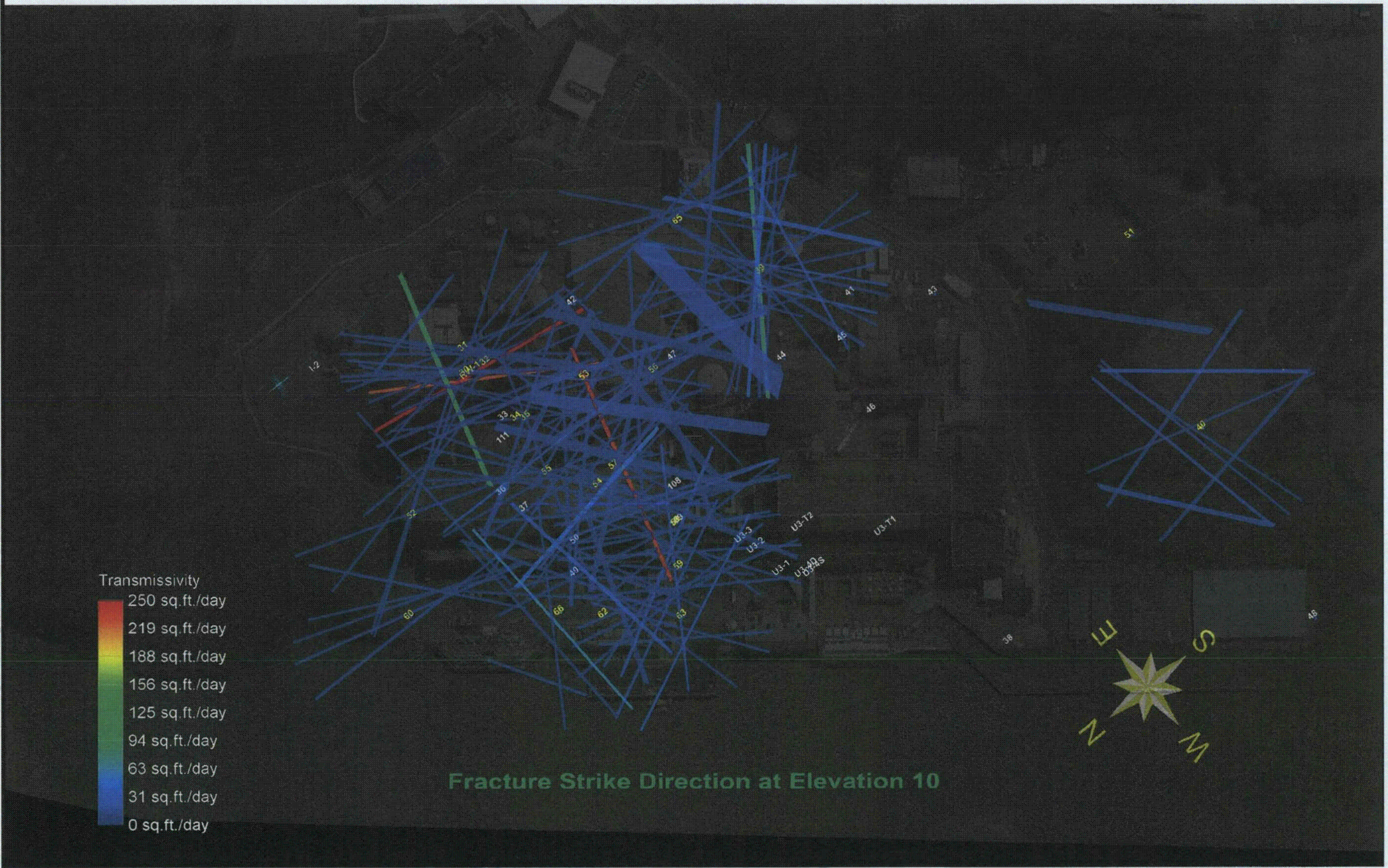
PROJ MGR: DMW
DESIGNED BY: DMW
REVIEWED BY: DMW
OPERATOR: GAS/EMD
DATE: 01-04-2008

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

FRACTURE PROFILE PROJECTIONS

PROJECT NO. 17869.10

FIGURE NO. 6.9



JOB NO. 17869.10

FIGURE NO. 6.13

INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK

FRACTURE STRIKE ORIENTATION AT ELEVATION 10

PROJ MGR: MJB
DESIGNED BY: JDR
REVIEWED BY: MJB
OPERATOR: JDR

DATE: 08-06-2007

GZA GeoEnvironmental, Inc.
ONE EDGEWATER DRIVE
NORWOOD, MA 02062
Ph.: (781) 278-3700
Fax: (781) 278-5701

GZA-J:\17,000-18,999\17869\17869-10.DW\Figures\November-2007-Report\17869-10_strike_lines_el_-100.dwg [FIG_6-14] January 04, 2008 - 4:26am Elaine.Donohue

JOB NO. 17869.10	INDIAN POINT ENERGY CENTER BUCHANAN, NEW YORK	PROJ MGR: MJB DESIGNED BY: JDR REVIEWED BY: MJB OPERATOR: JDR
FIGURE NO. 6.14	FRACTURE STRIKE ORIENTATION AT ELEVATION -100	DATE: 08-06-2007

GZA GeoEnvironmental, Inc.
ONE EDGEWATER DRIVE
NORWOOD, MA 02062
Ph.: (781) 278-3700
Fax: (781) 278-5701

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:14 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: Ex B - Egan 07 declaration.pdf

Attached please find Exhibit B to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

Janice A. Dean
Assistant Attorney General
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Please note new email address:
janice.dean@ag.ny.gov

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In re:	Docket Nos. 50-247LR and 50-286LR
License Renewal Application Submitted By	ASLB No. 07-858-03-LR-BD01
Entergy Indian Point 2, LLC, Entergy Indian Point 3, LLC, and Entergy Nuclear Operations, Inc.	DPR-26, DPR-64

DECLARATION OF BRUCE A. EGAN, SC.D.

1. I am president of Egan Environmental, an environmental consulting firm in Beverly, Massachusetts. My education and professional experience is summarized in the attached curriculum vitae.

2. I have been a specialist on the subject of air pollution modeling for over 35 years and am familiar with the development and application of dispersion modeling methods.

3. I have been retained by the Office of the Attorney General to comment on Entergy's air dispersion modeling for its Severe Accident Mitigation Alternative (SAMA) analysis.

4. I earned an A.B. degree from Harvard College in 1961 and an S.M. degree in Engineering and Applied Physics from the Harvard Graduate School of Arts and Sciences in 1962. I earned a second masters degree (S.M. 1969) and a doctorate (Sc.D. 1972) in Environmental Health Sciences from the Harvard School of Public Health. To support my doctoral thesis topic, Numerical Modeling of Urban

Air Pollution Transport Phenomena, I cross registered at the Massachusetts Institute of Technology to take courses in Meteorology.

5. Before starting my own company in 1998, I was Vice President and Technical Director at Woodward Clyde Consultants and, before that, Senior Vice President and Chief Scientist at ENSR Corporation. I have over 35 years of experience as a manager and environmental scientist on projects involving the development and application of atmospheric dispersion models to complex topographies, including mountainous terrain and coastal settings.

6. I have also performed accident and consequence analyses for risk management plans and modeling for both hypothetical and actual accidental release scenarios. I am the co-author of a book about compliance with the United States Environmental Protection Agency's (US EPA's) Risk Management Program under the Clean Air Act.

7. I have been an active member of the American Meteorological Society (AMS) for over thirty five years and have served on its committees relating to air pollution and meteorology. I am a Certified Consulting Meteorologist and an elected fellow of the AMS.

8. I have reviewed Entergy's License Renewal Application, the Environmental Report annexed as Appendix E to the application, and Attachment E to the Environmental Report supporting the SAMA analyses prepared by Entergy. I have also reviewed available documentation of the Melcor Accident

Consequence Code System (MACCS2) which was used by Entergy to perform its SAMA analyses, and Entergy's update to its FSAR.

9. The comments below relate to the use of the ATMOS air dispersion model (which is incorporated in the MACCS2 code) for purposes of estimating the number of people who will be exposed to radiation from a release of radio nuclides from the Indian Point Nuclear Power Station.

10. The Indian Point Nuclear Power Station is located in the northwest corner of Westchester County on the eastern bank of the Hudson River. The Indian Point reactors and spent fuel pools are approximately 24 miles north of the New York City line, and approximately 37 miles north of Wall Street, in lower Manhattan. The station is approximately 3 miles southwest of Peekskill, 5 miles northeast of Haverstraw, 16 miles southeast of Newburgh, 17 miles northwest of White Plains, and approximately 18 miles southwest of Brewster, New York. 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. 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.

11. The Indian Point Station is on a point of land that protrudes into the Hudson River as the river bends west. On the west side of the Hudson River one mile north of the station, is Dunderberg Mountain. This mountain rises to a height

of 1086 feet above sea level at a distance of approximately 2.5 miles from the station. North of the Indian Point Station, the eastern bank of the river is formed by high grounds reaching an elevation of 800 feet; to the west across the river, the Timp Mountains reach an elevation of 864 feet. Environmental Report, Appendix E at 2-1.

12. For purposes of categorizing appropriate air dispersion models for regulatory applications, EPA defines complex terrain as settings where nearby terrain heights exceed a facility's stack height. The Indian Point Station is located in a complex terrain. Releases from the station may come from near ground level sources or from stack vents with heights up to 334 feet and within 1-2 miles of high terrain features on the opposite side of the Hudson River, such as Dunderberg and the Timp Mountains, that rise well above the facility and well above the top of the 122 meter meteorological tower located onsite.

13. From a meteorological air flow perspective, the presence of the river, nearby terrain features and non homogeneous ground surface features, all affect the overall air flow patterns, which in turn affect the rates of vertical and horizontal mixing of any pollutants released from the plant. The presence of high terrain features that rise above the height of the meteorological towers at the Indian Point station means that the wind speeds and directions measured on the towers are unlikely to be representative of the larger scale flow patterns that carry contaminants from the plant to the surrounding areas. It is important that atmospheric dispersion modeling of the effluents from the plant consider these

factors in order to provide a reliable basis for estimating ground level concentrations and corresponding estimates of potential exposures to the surrounding population.

14. Entergy's air dispersion modeling does not provide an adequate technical basis for its SAMA analyses. The human health cost side of the cost-benefit analysis for any particular mitigation measure is based on the total population dose of radiation that results from an accident. The total population dose is estimated by using an air dispersion model to predict the geographic dispersion and concentration of the accidentally released radionuclides. To obtain an accurate estimate of total population dose, and therefore of human health cost, a model that accurately predicts the spatial distribution of the pollutant must be used. Entergy's reliance on the ATMOS air dispersion model for this purpose is inadequate because that model's simplified assumptions and limited meteorological inputs will not yield the most reliable predictions. That is why EPA does not recommend such models for use in complex terrains.

15. I will first briefly review the physical factors involved in the dispersal of pollutants from emission sources. I will then identify the specific deficiencies in the ATMOS modeling methods as they pertain to the Indian Point Station's license renewal application. I will then comment on the present state of the art of dispersion modeling referencing the advances made by the US EPA over the past decade. I will then suggest how the modeling could be improved to both adequately

support the SAMA analysis process and to form the basis for reliable emergency response plans for any future unforeseen releases from the facility.

I. OVERVIEW OF DISPERSION MECHANISMS IN THE LOWER ATMOSPHERE

16. Dispersion of contaminants released into the air from a source can be described as the combination of two mechanisms. The first is the advection or downwind transport of the contaminants by the wind. A major influence on wind speeds and wind directions at any given place is the location and strength of large scale high and low pressure system air masses that migrate across a geographic area. The downwind transport winds are also influenced by the dynamics in the lower levels of the atmosphere, and specifically by ground surface topographic features and by ground surface heating and cooling processes that can alter the flow speed and direction and generate local circulations as discussed in more detail below. See also Slade (1968), Chapter 2.

17. The second mechanism is the mixing of contaminants by atmospheric turbulence as the plume is transported downwind. The rate of mixing depends upon many factors arising from the interaction of the planetary boundary layer (the lowest layer of the atmosphere) with the earth's surface.

18. For example, heating of the earth's surface by solar radiation during the day results in the formation of small thermals or parcels of air that tend to rise upward because of their lower density compared to the surrounding air. Parcels of cooler air then descend to fill the space vacated by the thermals. These movements

generate turbulence. Pollutants under these conditions are vigorously mixed with the surrounding air. This condition is called 'unstable' because the buoyancy forces on the parcels prevent the parcels from being initially at equilibrium with the surrounding air.

19. Conversely, cooling of the earth's surface occurs from the radiation of heat from the surface at night and results in the formation of a layer of cooler air under warmer air. This "inversion" of the normal decrease of temperature with height above the ground tends to suppress turbulence in the atmosphere. Pollutants in this layer will mix slowly with the surrounding air as upward and downward motions are suppressed by buoyancy forces. This is called an atmospherically stable condition.

20. In the absence of strong heating or cooling of the ground surface or under high wind speed conditions, the mechanical friction generated by the wind flowing over the earth's surface creates turbulence having intensities between the extreme of unstable and stable flows. These conditions are called "neutral." Neutral conditions can occur during the day or night.

21. In order to create a model that accurately depicts the dispersion of pollutants from a source, the complexity of the relationships of the processes that drive dispersion -- wind speed, wind direction and atmospheric turbulence -- must be accurately accounted for.

II. SPECIFIC DEFICIENCIES AND LIMITATIONS OF THE ATMOS AIR DISPERSION MODEL

A. The ATMOS Model Predicts The Dispersion Of Pollutants In The Atmosphere By Using Dispersion Rates Devised In The Early 1960s Which Do Not Incorporate More Recent Scientific Understanding Of The Dynamics of the Atmospheric Boundary Layer.

22. An accurate depiction of the mixing of contaminants by atmospheric turbulence is essential to an accurate estimate of the dispersion of these contaminants over a geographic area. The dispersion rates in the ATMOS model were developed by Pasquill and Gifford in 1961 and are based on the observation that turbulent diffusion rates increase in intensity with increasing instability in the lower boundary layer.[1] Pasquill and Gifford developed a system of differentiating turbulent mixing rates by atmospheric stability categories and defined stability categories based on observations of rudimentary weather conditions, (e.g. wind speed, solar insolation and cloud cover) and time of day.

23. The diffusion rates associated with these rudimentary atmospheric stability classes are referred to as the Pasquill-Gifford (P-G) dispersion parameters. The ATMOS model adopted the Pasquill stability classification system and the corresponding Pasquill-Gifford dispersion parameters. However, ATMOS further modified the stability classifications by basing them only on measurements of the vertical temperature gradients between 10 and 60 meters above the ground or for releases above 85 meters, the temperature gradients between 10 meters and the height of the higher release point (NRC 2007).

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[1] See the attached List of Referenced Publications for complete citations.

24. The dispersion parameters were largely based upon a limited set of field experiments where dispersion of near ground-level releases of contaminants were used to measure the cross wind, lateral spread of plumes. Real field measurements of the vertical spread were limited and vertical spread estimates were based in large part on conservation of mass principles and an assumption that the distributions were Gaussian in shape. Atmospheric stability classifications from A to G (Extremely Unstable to Extremely Stable) were associated with different rates of growth of the standard deviations of the Gaussian shaped plume with increased distance downwind. The data base supporting these diffusion coefficients is not extensive and is limited to short downwind distances and flat, open terrain. Extrapolations and interpolations of the data were made to develop a complete set of continuous curves out to 100km (Turner, 1967).

25. Although the P-G method of assigning dispersion rates to stability categories was used for many years by US EPA in air dispersion modeling, US EPA has now adopted models that reflect advances in our understanding of the factors that affect the strength of turbulence in the atmospheric boundary layer directly above the earth's surface. These factors relate to the properties of the earth's surface, which include the surface roughness, the surface albedo (reflectivity), and the Bowen Ratio, a measure relating to the moisture content of the soil and the net heat flux from the surface to the air. See paragraphs 40-47.

26. As set forth below, the P-G dispersion parameters in the ATMOS model do not incorporate this more recent scientific knowledge about how

turbulence in the boundary layer is created and how that affects the dispersion of a release of pollutants.

B. ATMOS Utilizes A Steady State Straight Line Gaussian Plume Model To Calculate Concentrations Downwind Of A Release Point Which Is Inappropriate For The Terrain In Which The Indian Point Station Is Located.

27. In effect, ATMOS assumes that any emissions from the Indian Point Station are imbedded in an air mass having a single wind speed that flows for each period of simulation in a single straight line direction. The stability classification assigned for a simulation time period is also assumed to be constant over that time period.

28. The concentrations of contaminants within the plume are assumed to have a maximum value along the plume centerline and to fall off in a bell shaped, Gaussian distribution curve with distance away from the plume centerline. The horizontal and vertical dimensions of the Gaussian plume increase with downwind distance as a function of the assumed P-G atmospheric turbulent diffusion rates.

29. Neither the P-G method nor the straight line flow assumption is appropriate for determining air quality concentrations in areas where complex terrain alters the turbulent diffusion rates and alters the flow trajectories that pass up and over or around hilly or mountainous terrain objects. The P-G method and the straight-line flow assumption are not appropriate for regions where uneven ground surface heating results in the formation of local air circulations associated with mountain-valley upslope and down slope wind systems (Randerson,1984, Section 13-10). The presence of local flow regimes such as the mountain-valley

flows can greatly alter the trajectories and ultimate fate of contaminants. Therefore an air dispersion model that ignores the presence of such flows will provide erroneous information on environmental impacts.

30. For all the reasons set forth in paragraphs 22 through 29 above, the ATMOS model, with its P-G dispersion rates and straight-line flow assumption, cannot accurately predict the dispersion of pollutants released from the Indian Point Station, which is located in a complex terrain in a river valley that can alter the turbulent diffusion rates and the wind flow patterns.

C. ATMOS Cannot Accurately Calculate The Dispersion Of Pollutants Within A 50 Mile Radius Around The Indian Point Station

31. Entergy used the ATMOS model to predict the dispersion of radionuclides in a 50 mile radius around the Indian Point Station. However, the US EPA does not consider steady state Gaussian plume models to be accurate for setting emission limitations for distances beyond 50 kilometers (about 32 miles) from a source. For distances beyond 50 kilometers, the US EPA recommends using a "long range transport" model capable of simulating the effects of spatially varying wind directions. Such models generally use more than one source of meteorological data to define the spatial variations of the winds because even in flat terrain the likelihood of observing changes in wind direction increases with downwind distances. Further, at a distance of 50 miles, it is inappropriate to use the meteorological data from the onsite meteorology tower to define the wind speed and direction of contaminants emitted from the Indian Point Station because of the

influence of the nearby terrain on the winds at the meteorological tower. At 50 miles away, the winds are likely to be from a very different direction except under very strong wind conditions.

32. In addition, Entergy did not model the dispersion of radionuclides beyond a fifty mile radius of the station, despite the EPA's development of long range air transport models precisely for that purpose. See paragraph 45 for a discussion of one of these long range air transport models known as CALPUFF.

33. Since the determination of the cost effectiveness of a mitigation alternative under SAMA is based in part on the total population radiation dose, and since the number of people affected increases substantially with the radial distance from the Indian Point Station, the SAMA results are disproportionately influenced by impacts at large distances from the source and those impacts will not be accurately estimated by the ATMOS air dispersion model.

D. The ATMOS Model Cannot Account For Dispersion Patterns That Are Related To Changes In The Surface Characteristics Along The Plume Trajectory

34. In the ATMOS model, changes in surface characteristics along the plume's trajectory do not affect the model's dispersion rates. For example, a plume released from the Indian Point Station flowing towards an urban area would encounter very different surface roughness conditions as it entered a city. Such a change would rapidly mix an elevated plume down to the ground, a situation called fumigation. ATMOS would be unable to simulate such an event as it cannot incorporate changes in the turbulent mixing rates along a plume path.

35. Similarly, time varying changes of turbulence resulting in fumigation of plumes initially aloft cannot be accounted for. This would occur after ground surface heating in the morning creates a layer of highly turbulent air that extends upward into an effluent plume released earlier into a stable layer. Contaminants in the elevated plume can then be suddenly mixed down to ground level. This type of fumigation can occur at moderate distances from the station and subject populations at these distances to relatively high concentrations. This situation cannot, to our knowledge, be simulated with ATMOS.

36. A workshop was convened by the American Meteorological Society (Hanna, 1980), in which both Dr. Gifford and Dr. Pasquill participated, to review dispersion curves and to discuss alternative methods of determining stability categories that would provide more useful turbulence indicators in the surface layer.

37. The alternatives involved the use of the Richardson number or the Monin-Obukhov length since they are more direct measures of atmospheric stability. The workshop specifically recommended that the estimates of dispersion rates include the roughness length, and the friction velocity computed from wind profiles as measures of mechanical turbulence and that the mixing depth, and the heat flux or Monin-Obukhov length be used as measures of the convective turbulence during daytime hours (Hanna, 1982). US EPA adopted these recommendations in the development of the AERMOD model (US EPA, 2003).

E. The Change Of Mixing Depth With Time Of Day Is Not Incorporated In ATMOS

38. Mixing depth is an important variable in the determination of ground level concentrations at large distances from the station as it limits the vertical extent that turbulent mixing occurs during the day. Mixing depth is commonly determined by an analysis of vertical temperature soundings taken in the atmosphere. However, in the ATMOS model, the inputs for this variable are values averaged on a seasonal basis rather than using actual daily measurements. This is an unnecessary simplification in the model that affects its accuracy. Sounding data is routinely available daily from the National Weather Service stations in White Plains and in Albany and could replace the use of seasonally averaged values presently used in ATMOS.

F. The Information Entergy Provided In Its SAMA Analysis Is Inadequate For A Comprehensive Review Of Its Air Dispersion Modeling.

39. The information provided by Entergy is inadequate to allow a thorough review of its air dispersion modeling effort. There are no modeling input files that detail the source terms or meteorological events modeled. Also essential parameters used by the model such as the assumed roughness length, and deposition rate parameters are not included in the documentation.

40. There is no description of the MACCS2 model provided. I have based some of my comments on a description of the original MACCS model published in 1990 (Jow et al. 1990) and which may be out of date.

41. The meteorological data set used in the modeling which represents an average of data from the years 2000 through 2004 (Environmental Report at page E. 1-89) has not been provided. The use of multi-year averaged data in the modeling does not allow a review of the year to year variability of the output results.

G. Superior Models Have Been Developed And Can Be Applied To The SAMA Analyses.

42. The 1977 Clean Air Act Amendments (CAAA) resulted in regulations requiring modeling of the emissions from new sources that demonstrated that effluents from the source would not exceed specific ambient air quality standards and incremental increases of ambient air concentrations. These requirements placed responsibility on the US EPA to assure that modeling methods would be developed and tested to provide a reliable and defensible method of permitting sources subject to the new regulations. US EPA was required by the CAAA to recommend and approve new and advanced models and to provide guidance on model use. As a result, the US EPA initiated several activities to address improving dispersion models.

43. US EPA established a cooperative agreement with the American Meteorological Society to evaluate the state of the technology of modeling, solicit reviews of different modeling issues and recommend ways to improve models. The EPA held a conference to develop a modeling guideline and then subsequent conferences to recommend model evaluation and validation methods. US EPA also sponsored workshops to design field experiments to provide measurements to

validate models. US EPA then sponsored or co sponsored field measurement programs in several different terrain settings.

44. The technology of modeling advanced rapidly with both government and private sector research funds supporting the development of models for situations where existing models were not suitable. This included complex terrain settings, long range transport applications and limitations to models in simple terrain settings. US EPA recognized the fact that not only do the algorithms for individual components of a model (e.g., diffusion rates, plume rise, plume trajectories), need to be evaluated but importantly, the predictions of a model as a whole needs to be shown to be valid when compared to concentration measurement data.[2]

45. An important result of these efforts has been the development of the AERMOD and CALPUFF models. CALPUFF is a model that was originally intended for use beyond 50 km but is, in fact, applicable to many situations within 50 km.

46. AERMOD assumes a straight line trajectory but incorporates algorithms that calculate the horizontal and vertical spread of the plume in terms of wind fluctuation data, measured heat flux, surface roughness, albedo (reflectivity) and Bowen Ratio. Surface parameters can be specified as a function of location using land use input data. The interaction of elevated plumes with the mixing

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[2] Efforts to validate the ATMOS model by comparing its predictions with actual field measurements have been extremely limited. After a search of the literature, I have found only one study which compared real data with the ATMOS model's predictions and that study was limited in time and the data represented only neutral atmospheric conditions (Hills et al., 1998).

depth is also simulated in the model. AERMOD is suitable for most complex terrain settings.

47. CALPUFF would also be a more accurate model for SAMA analyses than ATMOS. CALPUFF is a non steady state model in which emissions from a source are released as a series of puffs each of which can be carried separately by the wind. This enables CALPUFF to simulate the effects of time varying winds and other meteorological inputs. It is also suitable for simulating the effects of spatially varying winds and meteorological parameters. It can simultaneously utilize data from multiple meteorological stations making it appropriate for long range transport simulations where data from several meteorological stations would be appropriate. Many of the algorithms in CALPUFF are based on the same improved knowledge of boundary layer parameters that was incorporated into AERMOD.

48. Today, the state of the art of dispersion modeling is further improving by major advances in our theoretical understanding of the dynamics of the atmospheric boundary layer. For example, the MM5 Meteorological model is a numerical simulation flow field model that can be used to drive numerical advection and diffusion models. It can calculate winds and other meteorological parameters using methods similar to those used by the National Oceanic and Atmospheric Administration and the National Weather Service to predict weather. These models are now routinely used for real time assessments of meteorology on a local scale - predicting winds, dispersion rates, precipitation, visibility and other factors and can be easily coupled to diffusion models to calculate air quality impacts. The US EPA

encourages the use of outputs from such models to drive long range transport models such as CALPUFF (EPA, 2005).

49. In fact, an advanced modeling method has been developed specifically to estimate the dispersion of radioactive releases from nuclear power plants. This model, the Atmospheric Release Advisory Capability (ARAC), was developed by the United States Department of Energy's Lawrence Livermore Laboratory (Leone, et al.1996, Baskett, 1999). ARAC is an atmospheric dispersion model that can model the dispersion of accidental radiological releases in highly variable winds. It uses windfields generated by meteorological models as inputs to a computational grid representation of the area of interest. ARAC was used as an analysis tool after the Chernobyl accident. With today's computers, ARAC or similar programs could be readily used in SAMA analyses.

Conclusion

46. For the above reasons, the ATMOS model cannot account for the effect of the complex terrain in which Indian Point is located, will not accurately estimate the dispersion of radionuclides at distances beyond 32 miles, cannot account for changes in surface characteristics along the plume's trajectory and does not incorporate the latest scientific knowledge about the physics of the atmospheric boundary layer.

47. Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on

November 27, 2007
Beverly, Massachusetts

Bruce A. Egan

LIST OF REFERENCED PUBLICATIONS

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Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:14 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: Ex C - Egan Declaration 09.pdf

Attached please find Exhibit C to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In re:	Docket Nos. 50-247LR and 50-286LR
License Renewal Application Submitted By	ASLB No. 07-858-03-LR-BD01
Entergy Indian Point 2, LLC, Entergy Indian Point 3, LLC, and Entergy Nuclear Operations, Inc.	DPR-26, DPR-64

DECLARATION OF BRUCE A. EGAN, SC.D.

1. I am president of Egan Environmental Inc., an environmental consulting firm in Beverly, Massachusetts. My education and professional experience are summarized in the attached curriculum vitae (Exhibit 1) and are described in detail below, with an emphasis on my experience that is directly relevant to the air dispersion modeling of a radioactive release from the Indian Point Power Station.

2. As I explain in this declaration, there is no material dispute in the scientific community or within the NRC itself that ATMOS cannot accurately predict the dispersion and concentration of a release of radionuclides from the complex terrain in which the Indian Point Power Station is located.

CURRICULUM VITAE

3. I earned an A.B. degree from Harvard College in 1961 and an S.M. degree in Engineering and Applied Physics from the Harvard Graduate School of

Arts and Sciences in 1962 where I specialized in Fluid Dynamics and Thermodynamics. After completing that degree in 1962, I became the Engineer-in-Charge of the Mechanical Engineering Undergraduate Instructional Laboratory at the Harvard University Division of Engineering and Applied Physics. My primary focus was designing and supervising the construction of new experiments and apparatus in fluid dynamics and thermodynamics for student use.

4. In 1964, my former advisor, Professor Arthur Bryson, hired me as Staff Engineer and then Associate Director of the National Committee for Fluid Mechanics Films (NCFMF). The NCFMF was producing 30-minute feature educational films with sponsorship from the National Science Foundation at the Education Development Corporation. At the NCFMF, I worked with several world renowned fluid dynamicists, the Film Principals, to design and develop experiments and methods for visualizing a variety of complex fluid flow phenomena. I became very interested in air pollution transport issues while working on films entitled 'Stratified Flows' and 'Turbulence'. Utilizing my fluid dynamics background, I also taught a course entitled 'Applied Aerodynamics' at Boston University for two semesters in 1966 and 1967.

5. When the NCFMF project ended in 1968, I enrolled at the Division of Environmental Health Sciences at the Harvard School of Public Health (HSPH) to further my education in air pollution. At the HSPH, I took courses including Physiology, Biostatistics, Epidemiology, Air Pollution Control, Air Pollution Meteorology, and Operations Research.

6. I earned a second Masters of Science degree (S.M. in Industrial Hygiene) in 1969 and earned a Doctorate of Science (Sc.D. 1972) in Environmental Health Sciences. My thesis was entitled Numerical Modeling of Urban Air Pollution Transport Phenomena. To support this thesis topic, I cross registered with the Meteorology Department at the Massachusetts Institute of Technology upon the advice of my thesis advisor, Dr. James R. Mahoney, where I took additional courses in Air Pollution Meteorology and Dynamical Meteorology.

7. For my thesis, I developed an innovative way to solve the advection and diffusion transport equations over an Eulerian grid which dramatically reduced the unwanted pseudo diffusion which was numerically introduced by finite difference methods. The method, known as the 'second moment method' was published in the AMS Journal of Applied Meteorology. (Egan and Mahoney, 1972a, 1972b) The moment method was used, improved upon, and extended to other applications by researchers internationally (Pedersen and Prahm, 1974; Nordo, 1974; Sykes and Henn, 1992; Kerr and Blumberg, 1992; Ghods et al., 2000).and has been extended to other fluid dynamics applications including oceanographic transport (Chu and Altai, 2001).

8. Upon passing my doctoral dissertation exam, I joined the environmental consulting company, Environmental Research and Technology Inc. that Dr. Mahoney had co-founded. As the company grew and changed names to ERT and then ENSR, over a period of 22 years, I advanced to the position of Senior Vice President and Chief Scientist.

9. Some of my early industrial work at ERT was associated with dispersion modeling of air pollution associated with smelters, paper mills and power plants located in complex, mountainous terrain. That work led the American Meteorological Society (AMS) to invite me to write a state of the art position paper on this subject for a workshop the AMS was holding on air pollution and environmental impact analyses (Egan, 1975).

10. I also managed a project to develop a site specific dispersion model for the Luke Mill, a large paper mill located in a river valley in complex terrain. The model development and validation effort required by this effort relied upon an extensive air quality monitoring program involving measurements of air pollution concentrations at various locations in high terrain together with meteorological data from towers based in the valley bottom and at a high point in the surrounding terrain. The study results illustrated the importance of appropriate meteorological measurements and appropriate model formulations to understand the impact of releases from sources in complex terrain. The project included an extensive model verification effort (Hanna, et al., 1984). The Luke Mill Model was used to establish emission limits on the paper mill for an EPA-required revision to the State of Maryland Clean Air Act State Implementation Plan. It was a predecessor to the RTDM model (Egan and Paine, 1986) which was later recommended by EPA for certain screening model applications (EPA, 2000).

11. As a result of controversies associated with dispersion modeling methods for energy development projects located in the western United States, the

United States Environmental Protection Agency (USEPA) requested proposals for the development and verification of a dispersion modeling method for use in the permitting of sources of air pollution located in complex terrain settings. ERT was awarded that project and I became the Project Director of the Complex Terrain Model Development project (CTMD) (Schiermeier, et al., 1983). The model was developed for use in stable atmospheric conditions (Venkatram et al., 1982) and required field studies to be performed during nighttime hours when the atmosphere is generally most stable.

12. Field experiments were performed at three different locations with different terrain geometries: an isolated hill, Cinder Cone Butte (Lavery et al., 1982), in south east Idaho, a long ridge (The Hogback) in the Four Corners area of New Mexico and a Full Scale Plume Study at the Tracy power plant in the Truckee River Valley east of Reno, Nevada (Lavery et al., 1983, NASA, 2005). Scale model laboratory experiments were also conducted by the EPA's fluid modeling facilities to provide data to verify the model trajectory parameters utilized (Snyder et al., 1985). The CTMD project study resulted in the development and verification of the Complex Terrain Dispersion Model (CTDM) (EPA, 1987; Paine et al., 1987) and later the CTDM PLUS model (Perry, et al. 1992). These models are based upon algorithms that calculate the detailed deformation, trajectories, and ground level concentrations of plumes that pass close to and around or above terrain features (Perry et al., 1992). The statistical performances of CTDM and CTDM PLUS were extensively validated with field data from several complex terrain sites. (Paumier et

al., 1990) and these models became the preferred refined EPA Guideline models for complex terrain settings (EPA, 2003). These models were recently replaced by AERMOD (described below). As a result of the CTMD model development and validation efforts, I was asked to write another review of the science of modeling in complex terrain for an international conference. (Egan, 1984)

13. I formed my own consulting company in 1998 and have continued with a specialty of modeling in complex terrain (Egan and Snyder, 2002; Egan and Murphy, 2007). In 2000, I performed an analysis for the PG&E National Energy Group of the effects of down slope winds from mountains near the Palo Verde Nuclear Generating Station (Palo Verde) near Tonopah, Arizona. The purpose of the analysis was to determine under what meteorological conditions the high terrain of a mountain between the meteorological tower at the Palo Verde site and the site of a proposed conventional power plant would interfere with the reliability of the meteorological data from the Palo Verde tower compared to data from a lower tower which was closer to the proposed plant. I provided recommendations based upon a review of several years of meteorological data. I have also worked more generally in complicated topographic and meteorological settings such as near building complexes using AERMOD and other advanced models. (Hanna, et al., 2000)

14. In 2002, for the Massachusetts Department of Public Health, I led a project and collaborated with other scientists and meteorologists from Pennsylvania State University, to develop a dispersion modeling capability for calculating the impact of releases from sources that may be affected by sea breeze circulations.

(Egan et al., 2002). That effort was based upon the application of a mesoscale meteorological model, MM5, that uses fundamental dynamical equations and parameterizations to develop complex and evolving meteorological predictions. (Seaman et al., 2002). The wind fields and dispersion parameters calculated with MM5 are used in conjunction with appropriate dispersion models, including CALPUFF and SCI PUFF to calculate time and spatially varying ambient air concentration values over a computational grid. I co-authored another review of dispersion modeling in complex terrain in 2001. (Egan and Snyder, 2001)

15. I have also performed accident and consequence analyses for risk management plans and modeling for both hypothetical and actual accidental release scenarios. I am the co-author of a book about compliance with USEPA's Risk Management Program under the Clean Air Act. (Egan and Heinold, 1997)

16. I have been an active member of the American Meteorological Society (AMS) for over thirty-five years and have served on its committees relating to air pollution and meteorology. I am a Certified Consulting Meteorologist. I am an elected Fellow of the AMS.

17. I have been a member of the Air and Waste Management Association for over 30 years, have continuously served on their meteorology committee and chaired a joint conference for the AMS and the AWMA on Meteorological Aspects of Air Pollution.

THE SCIENCE OF ATMOSPHERIC DISPERSION MODELING

18. Atmospheric dispersion modeling is the field of predicting the fate and the consequences of releases of contaminants into the atmosphere. Dispersion models are routinely used for determining compliance with ambient air quality regulations by state and federal environmental agencies, including assessing the incremental changes in air quality levels associated with the permitting of new facilities and for health risk assessments for nuclear energy facilities. Dispersion models use meteorological and emission rate information as inputs to mathematical algorithms that simulate the transport and dispersion of air pollutants. Dispersion models can estimate the ambient air concentrations, deposition rates of particles to ground surfaces at all places of interest and for different averaging times. Models can include chemical or nuclear atmospheric transformation algorithms to estimate dosages to exposed populations.

19. It is critical that the meteorological input data be representative of the air flow conditions between the source area and the locations of interest where air pollutant concentrations are being calculated. For example, if the purpose of the modeling is to predict the locations of higher pollutant concentrations, as in health risk assessment applications, the reliability of the model for that purpose is very sensitive to the wind directions input. If inaccurate wind direction data is put into the model, it may inaccurately predict high concentrations in the wrong locations, and far away from the actual locations of the populations at risk. The model's

reliability is thus crucial to decision-makers in environmental or public health and safety positions.

20. Another important factor in modeling is the presence or absence of high terrain in the study area. The presence of high terrain introduces several complicating factors into dispersion analyses. First, 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.

21. As described further below, the presence of valley sidewalls together with radiational cooling will cause drainage flows that further distort air flow directions.

22. The reasons that the straight line Gaussian model does not accurately predict air dispersion in complex terrain are fundamentally related to these multiple effects that the presence of high terrain has on altering the air flow dynamics.

23. The presence of high terrain may also degrade the ability of a single meteorological station to accurately represent the transport wind speed and direction that must be put in the model, especially for longer distance transport calculations. This is because wind directions measured near the surface will vary with location. The effect is most pronounced during the lighter wind and stable

atmospheric conditions that occur at night. This can be remedied by placing anemometers at higher elevations and by the use of multiple sources of meteorological data to provide information of the spatial variations of the wind.

24. Different models can be used depending upon the application and regulatory requirements. For example, EPA recommends simple screening models (EPA, SCREEN3, or CTSCREEN) that are structured to provide conservative concentration estimates for simple pass or fail determinations. If the estimates fail the test, i.e., if the concentrations are too high for regulatory compliance, the modeler would have an option of using a more refined model and more appropriate meteorological input data in further analyses. But even these screening models must be appropriate for the terrain in which the source is located. SCREEN3 is appropriate for sources located in flat terrain. CTSCREEN is appropriate for complex terrain. Where the goal is to ascertain the total amount of a pollutant to which a population would be exposed in the event of a release and the population density varies depending upon the direction and distance the plume takes following the release, screening technologies would be inappropriate because they could not provide a reliable upper limit exposure value without artificially assuming that all the released pollution reached the areas of highest population.

25. Where the purpose of the air dispersion model is to predict the actual exposure of individuals in the path of the pollutant plume in order to assign a monetary cost to the full extent of the potential health risk, and then to quantify in monetary terms the cost savings that can be achieved by mitigating that exposure,

the air dispersion model must have a high degree of accuracy to avoid either understating or overstating the economic costs and benefits involved.

26. The need for accuracy in the predictive model is particularly important where the number of individuals who could be exposed to the pollutant, and the level and duration of the exposure is greatly affected by the actual path of the pollutant plume once it is released from the source.

27. The need for accuracy in the predictive model is also particularly important where the economic costs of mitigation measures and the economic benefits of mitigation measures are fairly close, such as within a factor of 2 of each other.

28. Generally, the selection of a dispersion model depends critically upon the complexity of the meteorology and terrain influencing a release from a source and at what downwind distances reliable concentration projections are needed. In flat terrain settings with homogeneous surface characteristics (e.g., surface roughness, albedo and Bowen ratio) and relatively evenly distributed populations of interest, the simple straight-line Gaussian plume model algorithm is often appropriate. The Industrial Source Complex (ISC3ST) model (a Gaussian plume model) was used for such permitting applications by EPA until it was replaced by AERMOD (EPA, 2005). However, even ISC3ST was not deemed suitable for calculating concentrations on terrain elevations above the height of the source. This limitation was the reason that EPA sought the development of models appropriate for complex terrain settings. After the CTMD project, for sources located in complex

terrain (defined by EPA as in terrain that exceeded the height of release (EPA, 2003, p18452)), EPA's Guideline recommended the use of complex terrain screening models or the preferred refined model CTDM-PLUS (EPA, 2003, p18453). The adoption of AERMOD as a refined model (EPA, 2005) (70 F.R. 68218 (November 9, 2005) and now codified in 40 C.F.R. Part 51, Appendix W) for both simple (flat) and complex terrain settings obviated the need for separate refined dispersion models.

29. AERMOD was developed for applications within 50 Km (about 31 Miles) of a source. (Cimorelli, et al., 2005). 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. (Pasquill, 1961; Gifford, 1961). *See* ¶¶ 22 – 26 of my November 27, 2007 Declaration, annexed to this declaration as Exhibit 2, for a fuller discussion of boundary layer meteorology. Further, the AERMOD model was subjected to extensive statistical model evaluations in a variety of terrain settings. (Perry et al., 2005). These efforts showed that AERMOD represented a major improvement over the ISC3ST and other models.

30. The CALPUFF model is appropriate for simulating transport and dispersion in wind fields that change with space and time. Scire, et al., 2000a. It is often coupled to CALMET (Scire, et al., 2000b), a model that computes the needed wind and dispersion fields from meteorological data. CALPUFF may also be coupled to a full mesoscale meteorological flow model such as MM5. CALPUFF also

has benefited from advances in the parameterization of wind fields and turbulent dispersion over the past four decades. 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 (EPA, 2005). 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, do not have the capability to simultaneously use meteorological data from several different sources.

THE TERRAIN WITHIN WHICH THE INDIAN POINT POWER STATION IS LOCATED AND ITS VARYING POPULATION DENSITY

31. The Indian Point Nuclear Power Station (the "Indian Point Station") is located in the Village of Buchanan in the northwest corner of Westchester County on the eastern bank of the Hudson River. The Indian Point reactors and spent fuel pools are approximately 24 miles north of the New York City line, and approximately 37 miles north of Wall Street, in lower Manhattan. *Draft Supplemental Environmental Impact Statement,* Draft NUREG-1437, Supplement 38 ("DSEIS") at page 2-1. The station is approximately 3 miles southwest of Peekskill, with a population of 22,441, 5 miles northeast of Haverstraw, with a population of 33,811, 16 miles southeast of Newburgh, with a population of 31,400, and 17 miles northwest of White Plains, with a population of 52,802. 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. 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. DSEIS at 2-1. 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. DSEIS at 2-1. The total estimated population within a 50 mile radius of the Indian Point Station is more than 17 million. DSEIS at 2-3, Figure 2-1.

32. The Indian Point Station is on a point of land in the Hudson River valley that protrudes into the Hudson River as the river bends west. The region surrounding the Indian Point site has many peaks and valleys. DSEIS at 2-2. On the west side of the Hudson River, one mile north of the station, is Dunderberg Mountain. This mountain rises to a height of 1086 feet above sea level at a distance of approximately 2.5 miles from the station. North of the Indian Point Station, the eastern bank of the river is formed by high grounds reaching an elevation of 800 feet; to the west across the river, the Timp Mountains reach an elevation of 844 feet. DSEIS at 2-2.

33. For purposes of categorizing appropriate air dispersion models for regulatory applications, EPA defines complex terrain as "terrain exceeding the height of the stack being modeled." (EPA, 2003, pages 18452-18453) The Indian Point Station is located in a complex terrain. Releases from the station may come from near ground level sources or from stack vents with heights up to 334 feet and within 1-2 miles of high terrain features on the opposite side of the Hudson River,

such as Dunderberg and the Timp Mountains, that rise to heights greater than 800 feet and are well above the facility and well above the top of the 122 meter (400 feet) meteorological tower located onsite.

34. Attached as Exhibit 3 are two quadrangle maps prepared by the United States Department of the Interior Geological Survey for the Peekskill and Haverstraw quadrangles. These quadrangle maps contain topographic information and depict the complex terrain in the vicinity of the Indian Point Station, and enable a better visualization of the features that affect the dispersion of a release from the Station. Note that the Indian Point Station is located in a turning part of the Hudson River. The high terrain of Dunderberg Mountain to the west will distort and turn winds which might be measured to be from the east at the anemometer at the primary tower location. Even though the Hudson is still tidal at this location, under overall light wind conditions the net average downstream movement of the river water and the effects of drainage induced airflows will favor the downriver movement of air above and near the river surface (UFSAR Indian Point Unit 3 at Paragraph 2.5, p. 68). The presence of the moving river water surface adds an additional complexity to the air flows near the Indian Point Station. Also attached as Exhibit 3 is a less detailed map included in the DSEIS at Figure 2-9; this DSEIS map does not fully reflect the surrounding topography or the turns in the river.

THE ATMOS AIR DISPERSION MODEL IS SCIENTIFICALLY UNRELIABLE FOR USE AT THE TERRAIN IN WHICH INDIAN POINT IS LOCATED

35. ATMOS is a steady-state straight line Gaussian plume model which assumes that any emissions from the Indian Point Station are imbedded in an air mass having a single wind speed that flows for each period of simulation in a single straight line direction. The atmospheric stability classification is also assumed to be constant over that time period. Thus each simulation will predict that the pollutants will theoretically travel in a straight line to infinity or to the limits of the computational domain, regardless of topographical features that might render such a trajectory impossible.

36. The concentrations of contaminants within the plume are assumed to have a maximum value along the plume centerline and to fall off in a bell shaped, Gaussian distribution curve with distance away from the plume centerline.

37. The simplicity of the ATMOS model's assumptions are scientifically unreliable for use in the terrain in which Indian Point is embedded and the model therefore cannot accurately predict the geographic dispersion and concentration of a radionuclide release from that site.

38. From a meteorological air flow perspective, the presence of the river, nearby terrain features and non-homogeneous ground surface features all affect the overall air flow patterns, which in turn affect the rates of vertical and horizontal mixing of any pollutants released from the plant. Because there are nearby mountains that are higher than the meteorological tower at the Indian Point Plant, ATMOS, which can only use one meteorological source at a time, cannot predict the

wind speed and direction accurately from the meteorological data measured by that tower because wind speeds and directions in the valley are unlikely to be representative of the larger scale flow patterns that carry contaminants from the plant to the surrounding areas. It is important that atmospheric dispersion modeling of the effluents from the plant consider these factors in order to provide a reliable basis for estimating ground level concentrations and corresponding estimates of potential exposures to the surrounding population.

39. There are several effects of the terrain at Indian Point on air flow patterns, which cannot be accounted for by the ATMOS model. First is the deflection of the flow by the high terrain features. In the case of high terrain features across the river from Indian Point, air flow from the east will either turn and pass along the side of the mountain or rise over the mountain, depending upon atmospheric stability conditions. (Snyder, et al., 1985). Therefore, air pollution released from Indian Point and embedded in the air flow will not take the straight line trajectory across the river valley that would be predicted by the ATMOS model using data from the Indian Point meteorological tower. Under the more stable atmospheric conditions associated with greater ground level impacts, the plume is likely to be turned down the overall river valley as it cannot pass through the terrain.

40. A second effect of mountainous terrain on sources located in river valleys, such as Indian Point, is the creation of drainage flows by the presence of the valley side walls. For example, at night when the earth's surface cools by radiating

its heat upward, the air in contact with the surface cools. Because it is heavier than other air at that elevation, it flows under the forces of gravity down the valley slopes toward the base of the valley. In the absence of other influences, the pooling of the heavier air at the low point of the valley cross section causes that air to tend to flow downriver following the valley contours.

41. Meteorological models that incorporate effects of topography will simulate the phenomenon of valley sidewalls tending to channel air within the confines of the valley flows to follow the valley contours. Nighttime drainage flows in river valleys will tend to stay within the valley and flow in the same direction as the river itself.

42. A straight line Gaussian plume model cannot account for these phenomena, which could cause a night time radionuclide release to travel downriver towards the most populous areas in the fifty mile radius around Indian Point, including New York City and its surrounding suburbs – an area including approximately 17,000,000 people.

THE NRC, OTHER GOVERNMENT AGENCIES AND THE AIR DISPERSION MODELING COMMUNITY AGREE THAT STRAIGHT LINE GAUSSIAN PLUME MODELS CANNOT ACCOUNT FOR THE EFFECTS OF COMPLEX TERRAIN ON THE DISPERSION OF POLLUTANTS FROM A SOURCE

43. 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. In fact, the NRC 2009 Presentation supports the criticisms I set forth

here and in my previous declaration. The relevant portion of this presentation is annexed to this declaration at Exhibit 4; the full presentation is available at ML091050226, ML091050257, and ML091050269 (page references used here refer to the portion attached, Part 2, ML091050257).

44. The NRC, in its 2009 Presentation, states that the "most limiting aspect" of the basic Gaussian Model, is its "inability to evaluate spatial and temporal differences in model inputs." 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." NRC 2009 Presentation, Slide 33. However, Indian Point is located in the Hudson River Valley, and if meteorological conditions caused the plume to follow the valley downriver, radionuclides from the release would approach and perhaps reach, the most populated areas in the fifty mile radius around the plant.

45. The NRC 2009 Presentation also acknowledges the "gravity drainage" phenomenon I described above that could cause the plume to travel downriver towards New York City from a valley site such as Indian Point. As Slide 46 explains, the air in a valley is not heated directly by the sun but by heat convection from the earth. 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 downriver. Slide 46.

46. In its introduction to a discussion of advanced air dispersion models, the NRC 2009 Presentation summed up the Gaussian model's inability to project dispersion in a complex terrain:

> In many Gaussian models, terrain height is addressed only in determining the effective plume height.
>
> The impact of terrain on plume transport is not addressed.
>
> Straight-line models can not "curve" a plume around mountains or follow a river valley.
>
> NRC 2009 Presentation, Slide 33.

All of the above limitations apply to the ATMOS model. Significantly, the NRC 2009 Presentation then discussed the methods of more advanced models that *can* address terrain impact on plume transport, including models in which emissions from a source are released as a series of puffs, each of which can be carried separately by the wind, (NRC 2009 Presentation Slides 35, 36). This modeling method is similar to CALPUFF, which I describe above and in my earlier declaration (paragraphs 46, 47) as a model that could accurately predict the dispersion of radionuclides from a site such as Indian Point.

47. 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.

48. Indeed, even in an NRC research paper that shows small differences in outcome between a Gaussian, a two-dimensional and a three-dimensional model, a strong caveat is added about the use of simple straight line Gaussian models in complex terrain. This paper was prepared for the NRC in 2004 by the Lawrence Livermore Laboratory "to determine if the average ATD [Air Transport Dispersion] resulting from these codes are sufficiently close that more complex models are not required . . . or different enough that one or both of the NRC codes should be modified to provide more rigorous ATD." *Comparison of Average Transport and Dispersion Among a Gaussian, A Two- Dimensional and a Three-Dimensional Model*, Lawrence Livermore National Laboratory, October, 2004 at 2. ("Livermore Report") [1] (Ex. 5).

49. The site chosen for the study was the Department of Energy's Atmospheric Radiation Measurement Program Southern Great Plains Site in central Oklahoma and Kansas. The topography of Oklahoma and Kansas is relatively smooth, has minimal affect on the wind field, and the surface is fairly uniform and therefore produces relatively little thermal forcing." Livermore Report at 3. Although the authors "would have preferred a site with greater topographical and diurnal heterogeneity," the central Oklahoma and Kansas site was chosen as

[1] The study authors did not reach a judgment on this question but left it to the NRC to decide what to do with the study results. Livermore Report.

the only area with multiple wind and temperature measurements over a one year period." Livermore Report, Executive Summary at xi.

50. A significant caveat was added to the Report's summary about the scientific reliability of the use of ATMOS in complex terrains:

> . . .[T]his study was performed in an area with smooth or favorable terrain and persistent winds although with structure in the form of low-level nocturnal jets and severe storms. In regions with *complex terrain*, particularly if the surface wind direction changes with height, *caution should be used.* Livermore Report at 72. (emphasis added)

Thus, the Livermore Laboratory study supports the NRC 2009 Presentation and New York State's position that more advanced models than ATMOS should be used to accurately predict dispersion in complex terrains. [2]

51. As early as 1977 NRC began to question the feasibility of using straight line Gaussian plume models for complex terrain. *See* U.S.NRC, 1977, Draft for Comment Reg. Guide 1.111 at 1c (pages 1.111-9 to 1.111-10)(Ex. 6).

52. More recently, the NRC revised their Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants (US NRC, 2007). This document is attached as Exhibit 13. Regulatory Guide 1.23 recognizes the important relationship between meteorological measurements and atmospheric

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[2] It should be noted that a number of features of the Lawrence Livermore study make it inappropriate as a test of the reliability of the ATMOS model use at the Indian Point site for purposes of the SAMA analysis. First, the terrain used for the study is not complex, a feature which is the critical difference between Indian Point and other sites and is the critical feature that ATMOS is unable to address. Second, the study produced only annual averages which tends to smooth out the variations that occur during more discrete 24 hour events, which are the focus of the SAMA analysis. Third, while the report does not reject or endorse the ATMOS model for any particular NRC use, it does note that the variation between ATMOS and more sophisticated models was close to, or in excess of a factor of two, a difference that could be critically important in deciding whether to implement a particular mitigation measure.

dispersion modeling by stating 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."

53. On pages 4 and 5, Regulatory Guide 1.23 states that the program should be capable of providing the meteorological 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." 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 "The 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. These excerpts from Regulatory Guide 1.23 demonstrate 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 above, ATMOS is incapable of handling complex flow patterns and meteorological data input from multiple locations, Regulatory Guide 1.23 is an NRC recognition that it should not be used at a complex terrain site like Indian Point.

54. There are numerous other acknowledgments from the NRC and the U.S. Department of Energy about the inability of a straight line Gaussian plume model to account for the effects of complex terrain on the dispersion of a pollutant release. In 1996, the NRC acknowledged the inadequacy of simple straight-line Gaussian plume models to predict air transport and dispersion of a pollutant released from a source in a complex terrain when it issued RTM-96, *Response Technical Manual,* which contains simple methods for estimating possible consequences of various radiological accidents. 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." NUREG/BR-0150, Vol.1 Rev.4, Section Q; ADAMS Accession Number ML062560259, attached as Exhibit 7.

55. In December, 2005, as part of a cooperative program between the governments of the United States and Russia to improve the safety of nuclear power plants designed and built by the former Soviet Union, the NRC issued a Procedures Guide for a Probabilistic Risk Assessment, related to a Russian Nuclear Power Station. The Guide, 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." However, the Guide 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." *Kalinin VVER-1000 Nuclear power Station Unit 1 PRA, Procedures Guide for a Probabilistic Risk Assessment,* NUREG/CR-6572, Rev. 1 at 3-114; excerpt attached as Exhibit 8, full report available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6572.

56. The U.S. Department of Energy ("USDOE") has also acknowledged problems with the ATMOS simple straight line Gaussian plume model in the MACCS2 Code when used in complex terrain. For example, the Radiation Safety Information Computational Center ("RSICC") of DOE's Oak Ridge National Laboratory has a summary description of the MACCS2 Code in its Code Package CCC-652. 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." Exhibit 9.

57. 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.* DOE-EH-4.2.1.4 – MACCS2 Code – Code Guidance (excerpt attached as Ex. 10; full document available at www.hss.energy.gov/nuclearsafety/qa/sqa/central_registry/maccs2/final_maccs2_guidance_report_june_1_2004old.pdf). In Table 2-1, *Summary Description of MACCS2 Code Software*, under the heading Restrictions or Limitations, the Guidance also states that "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." Page 2-5. A separate 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." Page 6-1. (Exhibit 10).

58. The inability of a simple Gaussian plume model to accurately predict air transport and dispersion in complex terrains is such a basic flaw that it is discussed in a textbook for a college-level introductory course in environmental science and engineering. In listing the assumptions that are made to develop a simple straight line Gaussian plume model, the textbook warns that:

> 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 (Chapter 13 authored by William J. Moroz).

59. For over three decades atmospheric scientists and meteorologists have been identifying problems in the use of models similar to ATMOS for complex terrain settings like Indian Point. *See* Hanna et al., 1982 (attached as Ex. 11); Randerson, 1984, section 13-10. Also for several decades, meteorologists have been working to improve the methods and models which would provide much more reliable impact analyses for complex terrain than straight line Gaussian models. I have identified some of those efforts in this declaration.

CONCLUSION

60. In sum, there is a consensus in the scientific community of meteorologists that create and use air dispersion models, and government agencies that rely on them, that a simple straight-line Gaussian plume model, such as ATMOS, is scientifically unreliable when applied to the complex terrain in which the Indian Point power station is located and cannot accurately predict the dispersion and concentrations of radionuclides in a 50 mile radius of the Station. Because of these deficiencies, and because of the wide variations in population density within the 50 mile radius, the DSEIS's SAMA analysis could have grossly underestimated the number of people who would be exposed in a severe accident and the concentration of the doses they would receive. This would, in turn,

underestimate the "cost" of a severe accident and thus the "benefit" of a proposed mitigation measure that would reduce the magnitude of the initial release of radiation from the plant or reduce the probability of the release occurring, or both.

59. Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on

August 28, 2009
Beverly, Massachusetts

Bruce A. Egan
8/28/09

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Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:15 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: Ex D - Williams declaration.pdf

Attached please find Exhibit D to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

ENTERGY NUCLEAR INDIAN POINT 2, LLC
ENTERGY NUCLEAR INDIAN POINT 3, LLC
ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3

Regarding the Renewal of Facility Operating Licenses
No. DPR-26 and No. DPR-64 for an Additional 20-year Period

NRC Docket Nos.
50-247 & 50-286

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

DECLARATION OF RAYMOND C. WILLIAMS

I, RAYMOND C. WILLIAMS, declare under penalty of perjury that the following is true and correct:

1. I am an independent consultant for James Lee Witt Associates, part of GlobalOptions Group, Inc. ("JLWA"). I have 32 years of professional emergency management experience. I have earned a Masters of Arts in Political Science from the University of Chicago.

2. I worked for the Federal Emergency Management Agency ("FEMA") for 20 years, and the Defense Civil Preparedness Agency for 5 years before FEMA was created. I served for one year as Acting Regional Director in the San Francisco, California Region (FEMA Region 9) in 1998. I also served for 12 years as Deputy Regional Director in the Bothell, Washington Region (FEMA Region 10). As Deputy Regional Director, the requirements and obligations of the job included oversight of preparedness planning and operations, coordination with State and local governments, and federal disaster mitigation, response and recovery in the Pacific Northwest and Alaska.

3. I have considerable experience in national security issues and continuity of government, having been the Deputy Director of an interagency and interdisciplinary effort encompassing the whole west

coast. The work was highly classified. After retiring from federal service in 1999, I became the Authorizing Official for the Cerro Grande Fire Assistance Office, in Santa Fe, New Mexico. Under special and unique legislative authority, the responsibilities of this position included giving final approval to claims from victims of the controlled burn that spread though the city of Los Alamos in May of 2000.

4. James Lee Witt Associates, part of GlobalOptions Group, Inc. was founded by and is actively managed by James Lee Witt, who has a combination of executive level experience at the Federal, State, and local levels as an elected official and as a cabinet member. As Director of the FEMA, Mr. Witt was responsible for evaluating and exercising the emergency response plans for the Radiological Emergency Preparedness program for the Nation's nuclear power reactors. As Director of the Arkansas Office of Emergency Services, Mr. Witt was the coordinator for the State in nuclear preparedness, response, and evacuation capability for the Arkansas 1 and 2 reactors. Mr. Witt was also Chair of the Arkansas State Nuclear Advisory Board while serving as County Judge of Yell County, AR.

5. In 2003, I served as Project Manager for JLWA's review and analysis of the emergency responses of two multi-state utilities confronted by widespread hurricane-induced power outages. I have served as Project Manager for a JLWA team in 2004 sent to assist an independent island nation in the Caribbean recover from major hurricane damage to the island's infrastructure and housing. I have also served as Senior Advisor in 2004 to assist in the preparation of a Homeland Security Strategic Plan for the largest county in the State of Washington. I also served as Senior Advisor in 2006 for a JLWA project to analyze and improve the Emergency Management program for the City of Philadelphia.

6. In mid-2002, the New York Power Authority engaged JLWA to perform an independent review of the off-site emergency preparedness for two nuclear power plants in New York and Connecticut – Indian Point and Millstone, respectively. I was the Project Manager for this review. The review focused on efforts to ensure the safety of residents around the plant made by the State of New York, the four surrounding counties of Orange, Putnam, Rockland, and Westchester, and Entergy which is the operator and licensee of Indian Point. The independent review resulted in the 2003 *Review of Emergency Preparedness of Areas Adjacent to Indian Point and Millstone ("2003 Witt Report").* Our review identified serious problems, and we provided extensive and comprehensive recommendations for improvement.

7. The *2003 Witt Report* concluded that there were substantial issues with planning, training, and exercises that had to be resolved to ensure the safety of citizens in the surrounding areas from a

emergency involving a significant radiological release from Indian Point. In particular, JLWA raised issues about outdated and ineffective aspects of the planning process, inadequate public outreach and education, outdated communications systems and hazard assessment technologies, lack of first responder confidence in plans, problems associated with spontaneous evacuation, the inadequacy of the road system, and the high population density within the ten-mile Emergency Planning Zone ("EPZ").

8. Among other conclusions, the *2003 Witt Report* highlighted "significant planning inadequacies, expected parental behavior that would compromise school evacuation, difficulties in communications, outdated vulnerability assessment, the use of outdated technologies, lack of first responder confidence in the plan(s), problems caused by spontaneous evacuation, the nature of the road system, the thin public education effort, and how these issues may impact an effective response in a high population area." The Report concluded that

> *[N]one of these problems, when considered in isolation, precludes effective response. When considered together, however, it is our conclusion that the current radiological response system and capabilities are not adequate to overcome their combined weight and protect the people from an unacceptable dose of radiation in the event of a release from Indian Point. We believe this is especially true if the release is faster or larger than the typical exercise scenario.*

2003 Witt Report at viii.

9. In August 2007, the New York State Department of Environmental Conservation engaged JLWA to revisit its prior recommendations and determine what had occurred since the 2003 Witt Report. The State requested that JLWA review State, county, and Indian Point planning and exercise documents, media articles and published data on demographics, public opinion, and road construction, among other areas. We focused on the major issues from the *2003 Witt Report*. However, due to limitations due to the short NRC timetable for submitting the license renewal contentions petition, JLWA did not contact or speak with public safety and emergency management officials from the State, the counties, or Entergy.

10. A number of problems persist for the safe and effective evacuation of the residents around Indian Point and the 10 mile EPZ. These problem areas include roadway constraints and increasing population, the significant increase of evacuation times over 1994 estimates, the fact that the private sector is not sufficiently engaged in evacuation planning, the unique problems with school evacuations, the siren system failures at Indian Point, the lack of annual certifications by the counties since 2003, the uniqueness of the local terrain, the phenomena and implications of a fast-breaking scenario at Indian Point, and the hard lessons learned from Hurricane Katrina about the behavior of first responders. These issues are discussed below.

Roadway Constraints and Increasing Population

11. The issues that the *2003 Witt Report* raised about the road infrastructure surrounding Indian Point still exist. Based on information received by the counties, the road system around Indian Point is still not sufficient for a large-scale evacuation. Only one known road-widening program has been completed (Taconic Parkway) and a number of road resurfacing and maintenance issues remain unfinished, although Rockland County has resurfaced 80 percent of its county roads within the evacuation zone. However, due to the increased density of the population and the lack of significant road improvements since 2003, the original concern in the *2003 Witt Report* about the ability of the roads to handle a large-scale evacuation remains. The most recent figures from 2006 indicate that in aggregate the counties grew 4.49 percent from 2000 to 2006, with Orange County experiencing the greatest growth at 10.26 percent and Westchester the least at 2.8 percent. Population growth in areas served by rural roads makes the evacuation problems more difficult.

Evacuation Times Increased 66% over 1994 Estimate

12. The following table compares the results of the 1994 evacuation time estimates (ETEs) for Indian Point with the 2003 updated estimates provided by KLD Associates, Inc. *Indian Point Energy Center Evacuation Time Estimate, KLD Associates, Inc. (2003)("KLD Estimate Study").* The table shows a 66% increase in the estimated time an evacuation would require in favorable weather conditions.

	1994	*2003*
Evacuation Time Estimates for the entire EPZ.	Winter midweek midday good weather = 5:30 Summer weekend midday good weather = 5:40	Winter midweek midday good weather = 9:25 Summer weekend midday good weather = 9:25

13. KLD accounts for this increase by noting:

- An increase of approximately 10 percent in resident population, based on Census data.
- An increase in the number of evacuating vehicles per household of approximately 25 percent based on the results of the telephone survey.
- An increase of approximately 300 percent in the estimated number of employees commuting to the EPZ based on NYS trip-to-work data and employment statistics.
- Explicit consideration of the impact of Shadow Region traffic movement on evacuation time. *KLD Estimate Study at Chapter 1.*

14. While the surveys are not directly comparable because the 1993 study neglected shadow evacuation and there are methodological differences, the 66% increase in 2003 ETEs over the nine year period is significant, especially when considering the trend of population and employment figures continuing to increase. Shadow Evacuation is the spontaneous evacuation of people who are located outside the recommended evacuation zones. *2003 Witt Report at 215.*

Stakeholders Not Sufficiently Engaged in Evacuation Planning

15. The 2003 Witt Report recommended that Indian Point implement a region-wide process to engage stakeholders in developing emergency planning guidelines and performance outcomes. Such a process would improve the transparency of the planning effort and help the various actors in the region voice their concerns about the level of performance necessary in Indian Point's planning activities. In addition, it would allow plant, county, and State officials to counter charges that they did not factor outside opinions into planning functions. It would instead allow for the consideration of many issues that have been raised by advocacy groups that could strengthen Indian Point's plans. Finally, such a process would provide actors that are prominent in the community with a greater understanding of their role in an emergency. Unfortunately, we have found no evidence of systematic or frequent involvement of stakeholders in a region-wide process.

16. In addition, State and county radiological plans and the Indian Point Emergency Plan do not take into account the private sector for planning, exercising, or training. As with special facilities, large employers are responsible for the safety of a number of citizens within the EPZ, and should develop effective emergency response plans that care for employees and consider continuity of business operations. It is not a state or county responsibility to provide emergency planning for private businesses. However, the level of private emergency preparedness can inhibit or strengthen public emergency response, and, as such, large employers should be involved in the region's emergency planning process for radiological emergencies. Some employers, such as hospitals and ambulance and busing services, are covered under letters of agreement, but most employers in the 10-mile EPZ are not referenced in the county plans. Based on our limited review, there also does not seem to be any effort to assist employers with their internal contingency planning and business continuity planning.

Siren System Failures

17. Since the *2003 Witt Report*, Entergy has put a lot of effort into updating and replacing its siren system. In 2005, Indian Point had a series of high-publicity test failures of its sirens' backup capabilities.

In October 2005, 10 of the 16 sirens in Orange County failed to sound and in September 2005, none of Rockland County's 51 sirens worked. Possibly as a result, Indian Point decided to replace its existing 156 sirens with newer, electronic sirens that contained backup batteries, redundant activation methods, and the capability to transmit messages to cell phones, computers, televisions, and radios. The upgrades to the sirens were scheduled to be completed by January 30, 2007. However, Indian Point was unable to meet the January 30 deadline (and the extended deadline to April 15), and just barely met the third deadline on August 24, but missed the mandated federal review period for the sirens. The failure to address siren activation requirements resulted in NRC recommending a $130,000 fine, "*THE WEEK; Indian Point Faces Fine on Siren System*," Tim Murphy, New York Times, April 29, 2007. On September 12, 2007, FEMA inspectors noted that the new sirens are not loud enough and are blocking the sound from the original sirens, which are still installed as well.

Evacuation of Children from Schools in the Emergency Planning Zone.

18. The *2003 Witt Report* voiced concern that school evacuation procedures then in place would lead to a chaotic situation where parents would try to pick up their children (instead of relying on the school districts to transport them to reception areas outside the EPZ), and citizens would thus be alerted of the emergency through unofficial channels. The primary issue dealt with the policy of alerting schools and other special facilities before the general population, due to their unique considerations. Though this policy is understandable, logistically it presents an untenable situation where students would alert their parents and others via cellular phones, and the evacuation of schools would be thwarted by automobile congestion. Since the 2003 Witt Report, the radiological plans for the four counties surrounding Indian Point still state that school children will be evacuated from the area first. However, there is not a clear indication from the plans whether the counties would alert schools before the general public. For these reasons, the evacuation plans do not adequately address school evacuation issues.

Orange, Rockland and Westchester Have Not Submitted Annual Certifications since 2003

19. After issuance of the 2003 Witt Report, the Nuclear Regulatory Commission (NRC) and FEMA recertified Indian Point's emergency plans later that year. Orange, Putnam, Rockland, and Westchester Counties did not submit their annual certification that the emergency plans would effectively protect the public. Only Putnam County has since submitted a certification of Indian Point's emergency plans, in 2006.

20. The refusal of the counties to certify the effectiveness of their plans can have several competing interpretations. Some may claim the refusal to certify is merely a political decision and that, should there be an event, the counties will respond effectively using the same plans they refuse to certify. That may be so. But a competing interpretation is that the counties do not certify because they take certification seriously, and are no longer convinced that implementation of the plans will result in the protection of the populace. It is reasonable to assume that County Leaders take annual certification of evacuation plans for Indian Point seriously, and therefore, their refusal to certify the plan is quite significant. The State and Federal Governments are not in a position to step in and implement evacuation plans for the Counties. FEMA and NRC may think they can confidently certify in the absence of local certification, but Hurricane Katrina exposed such judgments as very risky and questionable. Even the White House's report on Katrina noted that "With respect to evacuation—fundamentally a State and local responsibility—the Hurricane Katrina experience demonstrates that the Federal government must be prepared to fulfill the mission if State and local efforts fail. Unfortunately, a lack of prior planning combined with poor operational coordination generated a weak Federal performance in supporting the evacuation ... The Federal effort lacked critical elements of prior planning, such as evacuation routes, communications, transportation assets, evacuee processing, and coordination with State, local, and nongovernmental officials receiving and sheltering the evacuees." "*The Federal Response to Hurricane Katrina – Lessons Learned*," United States White House, Washington, D.C., February 2006 at 56. It is not likely FEMA will invest in the planning effort it would take to be more successful in Indian Point than they were in Katrina when they optimistically indicate all is well by certifying plans the Counties decline to certify.

The Location of Indian Point Demonstrates Its Uniqueness from other Nuclear Generating Facilities Around the United States

21. *NUREG-0654, Rev. 1: The overall objective of emergency response plans is to provide **dose saving** (and in some cases **immediate life savings**) for a spectrum of accidents that could produce off-site doses in excess of Protective Action Guides. Emphasis added.*

Technical analyses underlying federal guidelines are, by nature, general and do not account for local variations. That is normal and acceptable, generally speaking. But there are variations in plants and surrounding communities that, in some cases, make attainment of dose saving through application of existing standards problematic. In the case of Indian Point, there are unique considerations that make protective actions more difficult and further unique considerations that make the consequences of failure greater. For example, in the *2003 Witt Report* it is evident that Indian Point was surrounded by jurisdictions with greater population densities than most nuclear power plants in the United States. Our traffic studies, and extensive travel in the area while preparing the *2003 Witt Report*, highlighted the inadequacy of the road system to handle a sizeable evacuation. Thus the road system made the implementation of evacuation difficult as a protective action strategy. At the same time the population density made the consequences of ineffective implementation of protective action strategies more serious. Thus, a generic analysis under NRC regulations does not consider local variations and cannot analyze or address the unique evacuation challenges posed by Indian Point.

22. Increasing population densities also aggravate other Indian Point evacuation problems identified and addressed in the *2003 Witt Report*. The problem of spontaneous evacuation becomes greater as the population within the EPZ rises, as do the problems surrounding the evacuation of school children, the problems of overloaded communication mechanisms, and overburdened and impassable roadways.

23. The unique evacuation challenges posed for Indian Point are dramatically worsened by first responders' and public attitudes regarding evacuation in a radiological emergency. We were surprised how many first responders within the EPZ told us in 2002 that, because they believe that the evacuation plans cannot work, they intend to get their family to safety before performing the emergency related requirements of their position. Making the situation worse and more complicated is the notable degree to which the local populace indicates that they will not take actions recommended by the plant and/or local jurisdictions. A survey was conducted by Ecology and Environment, Inc. for the New York State Emergency Management Office in July 2004 and February 2005 to provide a baseline, and again in July 2006 to determine changes. In 2004, 69 percent of respondents indicated that they would not follow advice from public authorities. The follow-on survey conducted in 2006 saw that number drastically increase to 91 percent. First responder intentions and attitudes found among the general populace work together to make it even less likely that the evacuation plans will be effectively implemented.

24. The dose saving standard used by the NRC makes sense and on its face may seem to be uniformly applicable to all nuclear power plants in the United States. But the barriers to effective evacuation plans must be taken into account, particularly with regard to unique situations posed by nuclear facilities like Indian Point. Thus, if the barriers to attaining dose savings through effective evacuation are greater at Indian Point, then the evacuation plans and actions taken need to be more effective and fully reflective of the unique challenges posed by Indian Point.

25. Unfortunately, NRC regulations do not seem to result in more effective emergency evacuation actions, as evidenced by the fact that FEMA certified the evacuation plans for Indian Point in 2003, and NRC accepted that certification, even though the plans and exercises omitted both realistic consideration

of spontaneous evacuation and the unique consequences of a terrorist attack (such as the site becoming a crime scene and the increased likelihood of a fast release). Consequently, any plant adjacent to high population areas should have different requirements than plants otherwise situated, because protective actions are more difficult and the consequences of failure or delay are higher. The standard, to minimize the radiological dose to the public, would remain the same; its accomplishment necessitates higher requirements in some communities than others, particularly unique situations like Indian Point.

Fast-breaking Radiological Release Event

26. The major problems identified in the *2003 Witt Report* that negatively impact an effective emergency response in the high population areas surrounding Indian Point would be heightened and exacerbated if the radiological release is faster or larger than the typical exercise scenario. All accident scenarios in the 1996, 1998, 1999, 2000 and 2002 exercises have followed the same pattern—there is a roughly one-hour time span between escalations of the event scenario. The 2004 exercise scenario had a terrorist strike as the initiating agent, but the exercise ended without a radiation release. The 2006 exercise reverted to the predictable pattern of 1996 – 2002, but the time between escalating site conditions was actually longer rather than shorter.

27. There has been no full-scale exercising of an event with a radiation release time of less than approximately three and one half hours.

28. Several examples can be provided clarifying why fast breaking events are important for effective and comprehensive emergency preparedness planning:

- The area surrounding Indian Point contains many special needs populations. The plans call for school bus drivers to collect these individuals and evacuate them after they have evacuated school children. However, if the event is fast breaking and the time window for action is narrow, there may not be sufficient time for the school buses to make this return trip to pick up special needs individuals.

- There are problems with communications interoperability and connectivity, especially in the more hilly Orange and Rockland counties. In fast-breaking events, these communication channels will need to carry more traffic.

- Evacuating a threatened area in a slowly developing event makes sense in the typical exercise scenario, the only scenario practiced, yet could be inadvisable in a fast breaking event (where shelter-in-place might result in a lower absorbed dose.)

Lessons on Evacuation Planning and First Responder Actions Learned from Hurricane Katrina

29. Following Hurricane Katrina and its aftermath in the media, I was intrigued by the reports of police officials evacuating with their families or, for reasons other than inability, not reporting for duty. The February 2006 Report of the US House of Representatives on the Katrina response noted that "Dereliction of duty by New Orleans Police Officers factored significantly into the department's inability to marshal an effective response. Original reports indicated that up to 320 officers (of its 1750 – officer force) resigned, were terminated, or are under investigation for abandoning their duties." *"A Failure of Initiative – Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina,"* U.S. House of Representatives Report by the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, February 15, 2006 at 246. While the Report does note that some of these officers were acting reasonably in response to conditions, the Katrina event validates our findings in the *2003 Witt Report* to the effect that first responders might provide for the safety of their families before they responded to the event. In this connection, it is interesting to note that, in general, the public is more fearful about radiation and radiological releases, particularly from nuclear power plants, than about the consequences to them and their families from hurricanes. Thus, the issue of first-responder behavior could be much more prevalent for a radiation release at Indian Point.

30. The United States Senate Report on Katrina offered differing numbers in their analysis of the situation. "At the time Hurricane Katrina made landfall, the [New Orleans Police Department] had a force of 1,668 sworn officers. By the time the storm had passed, at least 147 failed to report for duty, while 90 percent of the force remained on duty." *S. Rept. 109-322 – Hurricane Katrina: A Nation Still Unprepared Special Report of the Senate Committee on Homeland Security and Governmental Affairs*, United States Senate, Washington, D.C., (2006) at 441. It is clear that some officers abandoned their duty and evacuated with their families. In the case of an Indian Point evacuation, some first responders (in addition to police officers) in the EPZ said they would do the same and evacuate their families before carrying out their duties in the event of a significant radiological release. As Hurricane Katrina and the research for Indian Point demonstrate, significant numbers of first responders could either abandon their evacuation role or have their effectiveness greatly diminished because of family rescue actions they take prior to responding to the evacuation. Consequently, planning assumptions about the availability of first responders in a major event at Indian Point may be optimistic.

Emergency Preparedness Exercise Deficiencies

31. FEMA places much weight on exercises in preparing its certification to the NRC. The *2003 Witt Report* documented that biennial exercises did not accomplish their purpose, and made a number of significant recommendations for improvement. It is clear that serious deficiencies remain in the exercise program. The only significant issue that has been addressed so far is providing for a terrorism scenario, which was done in the exercise following our report. However, exercise scenarios have avoided one of the potentially most challenging evacuation scenarios that may face Indian Point and the surrounding communities -- a fast breaking off-site radiological release. Exercises continue to be conducted biennially, even though the *2003 Witt Report* recommended they be conducted annually because of the deficiencies identified in that review. The exercises still do not adequately address shadow evacuations. We have not seen any evidence of no-notice exercises. Non-English speaking populations are not fully accommodated in these exercises. Advocacy groups are still not allowed to observe exercises. The failure to implement these recommendations indicates that value of the exercises as indicators of effective response remains in question.

Conclusions

32. Evacuation planning inadequacies remain for the Indian Point nuclear generating facility, particularly in involving stakeholders in regional planning and exercising activities and in incorporating realistic expectations of public behavior. The difficulties of school evacuations have not lessened and the effectiveness of the evacuation plan in dealing with this special needs population remains questionable. The problem of spontaneous evacuation remains, as does the inadequacy of the road system in the areas surrounding Indian Point. Both of these problems are aggravated by the increase in population and in population density in the evacuation zone. Although public education has improved, much remains to be done before it is effective in influencing the public to follow the advice of authorities. Finally, although Entergy and the counties are not responsible for the current approach to exercising, it is clear that such efforts have not yet become the results-oriented approach the 2003 Witt Report recommended (and that FEMA is moving toward). Therefore, exercises cannot yet negate or mitigate the residual negatives our review has uncovered, and cannot demonstrate that a different conclusion is warranted.

33. There has been no detailed discussion and analysis of the evacuation plan or the evacuation issues raised in the *2003 Witt Report* in the applicant's license renewal submission to the NRC. The full

consideration of the evacuation planning issues facing Indian Point should an emergency situation releasing radioactivity off-site occur must be addressed. Given the significant failures identified in the evacuation plans for this nuclear facility, the NRC should conduct a rigorous inquiry by accepting the emergency evacuation contention of the State of New York and holding a public hearing to address these issues.

Pursuant to 28 U.S.C. section 1746, I declare under penalty of perjury that the foregoing is true and correct.

Dated: November 29, 2007

Raymond C. Williams

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:15 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: Ex E - Sheppard report.pdf

Attached please find Exhibit E to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

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Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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Potential Impacts of Indian Point Relicensing on Property Values

Summary of finding

I have been asked to report on the extent to which it is valid to regard the impact on off site land use of the continued operation of Indian Point 2 and Indian Point 3 as small in the sense of being undetectable or so minor as to not noticeably alter any important attribute of local resources, and in particular local land use. It is well established that, within regulatory bounds, land uses are determined by property values and the uses that tend to generate the highest values. In my examination of the existing research and evidence, I find that there are sound scientific reasons to expect that these impacts will **not** be small, and in fact may be substantial. The impacts can be expected to arise because of changes in property values that are associated with the presence of the power plant. The report below presents the basis for this finding.

Introduction

There have been several scientific studies of the impacts of power generating plants, in general and nuclear fission power plants, in particular. The most useful of these, for present considerations, are those that have determined the impacts, if any, on property values. These studies are the most useful because it is the market value of property that is the most significant determinant of its use and maintenance. To assert that the changes in land use in the area around the Indian Point nuclear power plants will be small is equivalent to asserting that the impacts on property values of extending the operating license will be negligible. If the presence of the nuclear power generating plant has a significant impact on property values, then it logically follows that extending the license will have a significant impact on property values which in turn will affect land use by affecting the decisions made by thousands of property owners and developers. Whether this significant impact exists is a scientifically testable question.

Blomquist[1] was one of the first to present a scientifically sound estimate of the impact of power plants generally on property values, and to publish the result in a peer-reviewed journal. It is plausible that such land uses will be the source of modest to severe levels of nuisance and disamenity that could depress the market value of nearby properties. His analysis found that, after adjusting for other factors (property size, demographic composition of neighborhood, etc.), there was a clear and statistically significant impact of power plants on property values. The impact was most

[1] Glenn Blomquist, "The Effect of Electric Utility Power Plant Location on Area Property Value" *Land Economics*, Vol. 50, No. 1. (Feb., 1974), pp. 97-100.

clearly detectable up to a distance of 11,500 feet from the power plant. Within this zone, increasing the distance from the power plant by 10% was associated with an increase in market value of 0.9 percent. This level of impact was evaluated for sample mean properties, meaning that it could be expected to hold for typical properties in the area around the power plant. It did not cover the impacts on commercial properties.

Do these results hold for the particular case of nuclear power plants? The careful analysis across several urban areas undertaken by Clark and Nieves[2] suggests that if anything the impact of nuclear power plants is larger. Their analysis uses data covering the entire United States and includes the impacts of 21 nuclear power plants as well as 39 coal-fired and 53 gas or oil-fired generating facilities. They find impacts to a reasonable and professionally accepted degree of scientific certainty from all types of power plant. Their analysis further indicates that the impact of nuclear generating plants is more than 3 times the impact of coal fired plants and more than 4 times the impact of gas and oil fired generating facilities. Their analysis is particularly valuable because they have been careful to separate the impacts of the plants themselves from the employment or income-generating impacts of power plants. This must be done to isolate the pure impact of the power plant that would be observed if the facility is completely replaced with an alternative use that is also capable of generating employment and income.

Not all published studies suggest clear negative impacts, but those that suggest zero impacts or ambiguous impacts generally have flaws in their scientific design. For example, Clark, Michelbrink, Allison and Metz[3] estimate a hedonic model for residential property values around two nuclear power plants located in California. They find small increases in property value associated with proximity to the power plants.

The analysis of Clark *et al.* openly combines both the impact of job accessibility with the impact of disamenity and nuisance associated with proximity to the nuclear power plants. Combining these two impacts would be an appropriate technique for estimating the impact of the nuclear power plant ONLY in the case where the counter-factual being evaluated was complete removal of the plant **and abandonment of the land**. For most cases, and certainly in the case of decommissioning of the plant contemplated in the Indian Point case, this is not the appropriate question to ask. Decommissioning of the plant entails removal of all radioactive materials from the site and making the site available for alternative use. In the Indian Point case, the highest and best alternative use of the site where the nuclear power plant is located would certainly NOT be abandonment, but rather a combination of attractive riverfront development that would be likely to include employment and other attractive locations. It is therefore not scientifically valid to assert that the results of Clark *et al.* could be applied to the Indian Point site.

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[2] David Clark and Leslie Nieves, "An Interregional Hedonic Analysis of Noxious Facility Impacts on Local Wages and Property Values" *Journal of Environmental Economics and Management*, Vol. **27** (1994), pp 235-253.
[3] David Clark, Lisa Michelbrink, Tim Allison and William Metz, "Nuclear Power Plants and Residential Housing Prices" *Growth and Change*, Vol. **28**, (1997) pp 496-519.

The study by Folland and Hough[4] does a somewhat better job of adjusting for the local employment effects, but unlike the Clark and Neives study discussed above does not fully account for the labor market impacts. They look at the impacts on the value of commercial or potentially commercial land in 494 market areas around the United States in years ranging from 1945 to 1992. They confirm that there is a statistically significant negative impact on property values that results from installation of a nuclear power plant.

In conclusion, there is clear scientific evidence that the presence of nuclear generating plants can reduce the value of property in the area around the plant. There are differences between the studies about how far the impact might extend, and about the magnitude of the impact. All properly done studies, however, indicate the potential for a significant, not a small, impact. In the next section I will present some estimates of how large that impact might be in the Indian Point case.

Analysis

In order to obtain a general estimate of the magnitude of property value impacts, I have made use of data available from the 2000 Census for the region around the Indian Point generating facility, making appropriate adjustments as described below.

A conservative estimate of property value impacts can be obtained by applying the impact estimated by Blomquist discussed above. His analysis suggested that there are no impacts on property values beyond 11,500 feet, and that up to that distance moving 10% further away from the power plant would increase the value of the property by 0.9%.

According to the 2000 Census, there are 32,427 persons living in Census Block Groups whose center is within 2 miles of the Indian Point facility. Within this area there are 12,933 housing units. The area around Indian Point and the associated census block groups are illustrated in Figure 1 below. The block groups are shaded blue with darker shades indicating more dwelling units. Of these dwellings, 6886 units are owner occupied units whose collective value in 2000 was $1,425,552,500 (over $1.4 billion). There were 5468 renter-occupied properties, whose average median contract monthly rent was about $750 per month. I approximate the value of the rental properties by calculating the discounted present value of the stream of rents that can be earned, and this produces an estimated value of rental property in the area of $816,613,800 (nearly $817 million). Combining these indicates that as of the 2000 Census the total value of residential property within 2 miles of the Indian Point facility was about $2,242,166,300 ($2.2 billion).

[4] Sherman Folland and Robin Hough, "Externalities of Nuclear Plants: Further Evidence" *Journal of Regional Science* Vol. **40**, No. 4, (2000) pp 735-753.

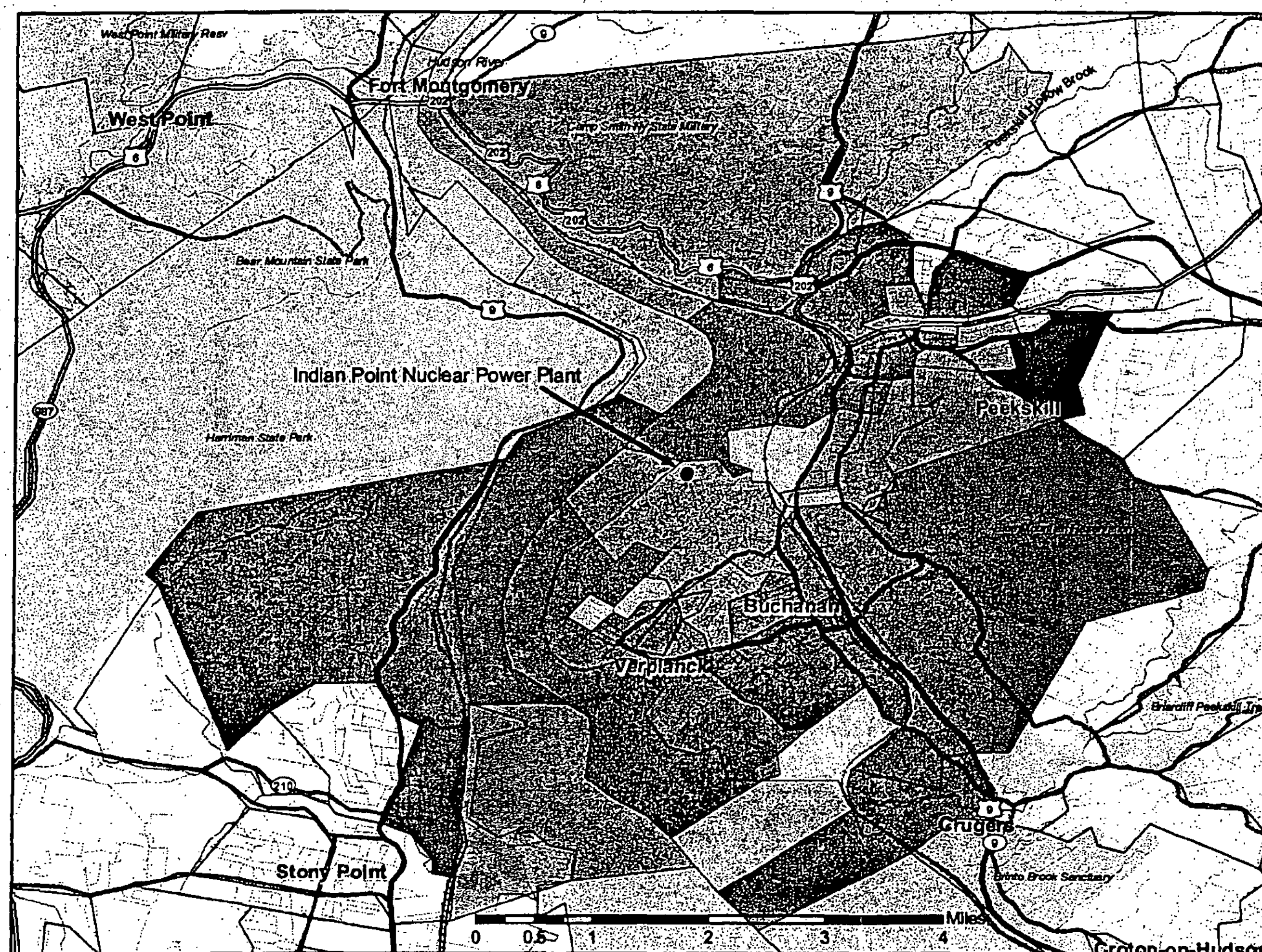

Figure 1: Region around Indian Point Nuclear Power Plant

Property values have continued to increase with the overall market, and the Office of Federal Housing Enterprise Oversight (OFHEO) tracks the course of house prices in every state and many metropolitan areas in the US. Using the index for the state of New York indicates that on average house prices have increased 93% from the first quarter of 2000 to the first quarter of 2007. Therefore the current market value of residential property within 2 miles of the Indian Point plant is approximately equal to $4,327,380,959 (over $4.3 billion).

For each Census block group, I calculated the percentage increase in distance from the Indian Point plant that would be required to move the block group to be 11,500 feet away from the plant. This is a very conservative estimate, based on Blomquist's study, of how far away from the plant properties would have to be to be free of impact from the plant. To be particularly certain that I obtain a minimum estimate of the impact, I excluded those houses in the block group that actually contain the plant, since these are not typical of the sample in a way that would make application of Blomquist's results scientifically valid in all circumstances.

The resulting calculations indicate that removal of the impacts of the Indian Point Nuclear plant would increase property values by $576,026,601 (over $500 million). This is clearly sufficient to alter the decisions about land use made by the owners of the most affected properties. The result indicates that the assertion that the impacts of extended licensing of the plant would be non-existent or undetectable cannot be accepted as scientifically valid.

Concluding remarks

The results presented in the report above provide a very cautious preliminary estimate. I have not considered the impact on commercial or agricultural property, although research suggests that these impacts can be significant as well. I have used a scientifically respected result based on analysis of power plants in general, while research suggests that the impact of nuclear power plants can be several times higher.

Finally, I have made use of the Census data only because they are widely regarded as reliable. A more complete analysis of residential and commercial properties is possible using detailed data from property tax records and land use information obtainable from the individual communities in the region. This would also permit examination of the extent to which the impacts extend beyond the very localized area I consider in this report.

Mendiola, Doris

From: Janice Dean [Janice.Dean@ag.ny.gov]
Sent: Tuesday, January 12, 2010 1:16 PM
To: Rulemaking Comments
Cc: Janice Dean; John Sipos; Teresa Fountain
Subject: Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments: Ex F - Lahey excerpt.pdf

Attached please find Exhibit F to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
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Janice Dean

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3

USNRC Docket Nos.
50-247 & 50-286

Regarding the Renewal of Facility Operating Licenses
No. DPR-26 and No. DPR-64 for an Additional 20-year Period

DECLARATION OF Dr. RICHARD T. LAHEY, Jr.

I, Richard T. Lahey, Jr., declare under penalty of perjury that the following is true and correct:

1. I am currently the *Edward E. Hood Professor of Engineering* at Rensselaer Polytechnic Institute (RPI) in Troy, New York. I hold the following academic degrees: a B.S. in Marine Engineering from the United States Merchant Marine Academy, a M.S. in Mechanical Engineering from RPI, a M.E. in Engineering Mechanics from Columbia University, and a PhD. in Mechanical Engineering from Stanford University. At RPI, I have served as both the Dean of Engineering and the Chairman of the Department of Nuclear Engineering & Science. I am a member of various professional societies, including: the American Nuclear Society (ANS), where I was a member of the Board of Directors and Chair of the Thermal-Hydraulics Division; the American Society of Mechanical Engineers (ASME), where I was Chair of the Nuclonics Heat Transfer Committee, K-13; the American Institute of Chemical Engineering (AIChE),where I was the Chair of the Energy Transport Field Committee; and the American Society of Engineering Educators (ASEE),where I was Chair of the Nuclear Engineering Division. I was also the editor of the *Journal of Nuclear Engineering & Design*. In addition, I have served on numerous panels and committees for the United States Nuclear Regulatory

Commission (USNRC), Idaho National Engineering Laboratory (INEL), Oak Ridge National Laboratory (ORNL), and the Electric Power Research Institute (EPRI). I am a member of the National Academy of Engineering (NAE), and have been elected Fellow of both the ANS and the ASME. Over the last 40 years, I have published numerous books, monographs, chapters, articles, studies, reports, and journal papers on nuclear engineering and nuclear reactor safety technology., and most of these publications have been peer reviewed. My *curricula vitae*, which more fully describes my educational and professional background and qualifications, is available at: **http://www.rpi.edu/~laheyr/laheyvita.html**.

2. I am very familiar with the operation of, and safety analyses associated with, pressurized water nuclear reactors (PWRs), the type of reactor currently in operation at the Indian Point (IP) site in Buchanan, New York.

3. I have reviewed the license renewal application for the two Indian Point nuclear reactors that was submitted by Entergy Nuclear Operations, Inc. (Entergy). These reactors are known as Indian Point-2 (IP2) and Indian Point-3 (IP3). In my opinion, and as I explain more fully below, the United States Nuclear Regulatory Commission (USNRC) should grant a hearing on at least five aging management and safety issues: (1) embrittlement of the reactor pressure vessels and associated internals; (2) the potential for fatigue failure; (3) inadequate baseline inspections of IP2 and IP3; (4) the need for enhanced inspections because of an inadequate water/cement ratio in the containment structures; and, (5) the risk of a terrorist attack on the spent fuel storage pools.

4. As nuclear power plants exceed their normal design life of 40 years, key structural components degrade – they begin to wear out. To assure safe operation during a 20-year life extension of the IP reactors, it is imperative not to erode the original design safety factors in the

enhanced inspections of the containment structures throughout any license renewal term. In other words, because of this construction deficiency, the Indian Point containment structures require a more thorough and frequent monitoring protocol than would a facility that met the required water/cement ratio. Entergy, however, has not proposed to do enhanced inspections in its relicensing application. *See generally* LRA. Thus, the USNRC should require Entergy to perform enhanced inspections of the IP2 and IP3 containment structures, or to conclusively prove that these inspections are not required.

Terrorist Attacks on Spent Fuel Pools

31. A fifth issue on which the USNRC should conduct a hearing on Entergy's relicensing application for IP2 and IP3 is the safety of the storage of spent fuel, and the consequences of a terrorist attack on the spent fuel pools at all three of the Indian Point reactors. This issue arises from the USNRC's severe accident mitigation analysis (SAMA) and its review of environmental impacts under the National Environmental Policy Act (NEPA). A terrorist attack on the spent fuel pools could result in radiation releases that could cause significant adverse environmental and health effects and property damage in one of the most populated areas of the country – the New York metropolitan area.

32. All three Indian Point plants have spent fuel pools outside their containment buildings that contain large quantities of radioactive material. After it is used in nuclear reactors to generate energy, spent nuclear fuel remains extremely radioactive. To protect workers, facilities, and neighboring communities, most nuclear power plants in the nation have constructed large swimming-pool-like structures in which the spent fuel was to be stored temporarily until it cooled sufficiently to allow its transfer to a final disposal site in the United States. Because no final disposal site has yet been developed, the spent fuel has remained for decades in these temporary

storage pools. The storage pools are susceptible to fire and radiological releases in the event the pools drain.

33. I served as a member of a committee that conducted a study under the auspices of the National Research Council (NRC) of the National Academy of Sciences (NAS), which reviewed the safety and security of spent nuclear fuel storage. The committee was officially called the "Committee on the Safety and Security of Commercial Spent Nuclear Fuel Storage of the Board of Radioactive Waste Management," and it reported directly to the United States Congress. In 2005, the National Research Council published both public and classified reports of the Committee's study, which I co-authored. The public report, "Safety and Security of Commercial Spent Nuclear Fuel Storage," is attached as **Exhibit A**. (National Research Council of the National Academies, *Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report*, (copyright 2006) (hereinafter called the *NAS Study*). I understand that the State of New York will request that the ASLB be allowed to review the National Research Council's confidential report during the license renewal proceedings. In any event, my colleagues on the National Research Council Committee and I studied various possible terrorist attack scenarios, and we concluded that spent fuel pools, such as those at Indian Point, are indeed vulnerable to such attacks.

34. Regarding the potential of an attack on the three spent fuel pools at the Indian Point plants, the Generic EIS state that "if such an event were to occur, the resultant damage and radiological release would be no worse than expected from internal events." *See* USNRC's Generic Environmental Impact Statement (NUREG-1437 Vol. 1): § 5.3.3.1 (Review of Existing Impact Assessments). The Generic EIS conclusion may be true for a terrorist attack on or within the primary containment, but it is most certainly not true for a terrorist attack on any or all of the three spent fuel pools at Indian Point. Indeed, far more radioactivity is present in the spent fuel

located in the three spent fuel storage pools at Indian Point than there is in the active core of the two nuclear reactors.

35. Additionally, the spent fuel pools are not enclosed by a leak-tight containment structure. Rather, they are surrounded by only a confinement building, which is not a leak-tight containment structure. Thus, if a terrorist attack leads to pool drainage and a propagating zirconium fire, much of the radioactive inventory in the spent fuel could be released to the environment. The resulting plume of radiation released into the atmosphere can result in significant adverse environmental and health effects and property damage in and around the Indian Point plants, including New York City (NYC), and the immediate portions of northern New Jersey and southwestern Connecticut. Approximately twenty million people reside or work within a 50-mile radius of NYC. At risk, too, are trillions of dollars of property in the tri-state region and, of course, the financial capital of the world (NYC) could be seriously disrupted.

36. The NAS Study made several recommendations for mitigation, including the rearrangement of the spent fuel in the storage pools and spray cooling. Entergy has not indicated in its relicensing application that it has adopted these mitigation measures for any of the spent fuel pools at Indian Point. Although Entergy is apparently moving some of its spent fuel from the spent fuel pools to dry cask storage, that will not completely mitigate the threat outlined above since the most highly radioactive fuel generates the most decay heat and thus must remain in the spent fuel pools. In other words, the two active reactors will continually generate more spent fuel during the proposed renewal period, and because of its decay heat and radioactivity, this spent fuel must remain in the spent fuel pools for some time before it can be moved to dry cask storage (i.e., the natural convective cooling by air in dry cask storage can not keep this fuel cool enough).

37. Moreover, the movement of some spent fuel from the Unit 2 and Unit 3 spent fuel pools to an on-site dry cask storage area will not significantly reduce the density of spent fuel

inside those units' pools because the two reactors will continually generate more spent fuel during any renewal period. Nor does the LRA evaluate these mitigation alternatives.

38. Finally, given the proximity of these plants to New York City, the potential health, environmental, and financial impacts are very significant – much more so than at any other nuclear power plant in the nation. Thus, Entergy's application for license extension must consider all reasonable severe accident mitigation alternatives (SAMA) concerning a terrorist attack on the spent fuel pools.

Conclusion

39. In summary, these five aging and safety related issues – (1) embrittlement of the reactor pressure vessels and associated internals; (2) the potential for fatigue failure; (3) inadequate baseline inspections of IP2 and IP3; (4) the need for enhanced inspections because of inadequate water/cement ratio in the containment structures; and, (5) the risk of a terrorist attack on the spent fuel pools – all demonstrate that IP2 and IP3 have significant aging and safety related issues that need to be addressed in the context of this relicensing proceeding. The applicant has glossed over many of these issues, to the extent that it has addressed them at all. The USNRC should conduct a very rigorous inquiry by accepting these contentions and holding a hearing on each of them.

Pursuant to 28 U.S.C. §1746, I declare under penalty of perjury that the foregoing is true and correct.

Dated: November ___, 2007
Troy, New York

R. T. Lahey

Richard T. Lahey, Jr.

Mendiola, Doris

From:	Janice Dean [Janice.Dean@ag.ny.gov]
Sent:	Tuesday, January 12, 2010 1:16 PM
To:	Rulemaking Comments
Cc:	Janice Dean; John Sipos; Teresa Fountain
Subject:	Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments:	EX G- Sykes declaration w figures and references.pdf

Attached please find Exhibit G to the State's comments.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In re:	
License Renewal Application Submitted by	**Docket Nos. 50-247-LR, 50-286-LR**
	ASLBP No. 07-858-03-LR-BD01
Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Operations, Inc.	**DPR-26, DPR-64**

DECLARATION OF LYNN R. SYKES

Lynn R. Sykes, Ph.D. hereby declares under penalty of perjury that the following is true and correct:

1. I am currently the Higgins Professor Emeritus, Earth & Environmental Sciences at the Lamont-Doherty Earth Observatory of Columbia University.

2. During the course of my career, I have studied seismic issues in the throughout the United States and the world. Among the areas I have studied is New York City Seismic Zone (which includes portions of New York State, New Jersey, Pennsylvania, and Connecticut). My CV is attached to this declaration.

3. I have prepared a report concerning earthquake activity in intraplate continental regions such as eastern North America, with emphasis on issues directly relevant to earthquake hazard in the greater tri-state New York City

Seismic Zone and the area in and around the site for the Indian Point Nuclear Power Station. Among other things, the report concludes that: (1) the application for license renewals for IP2 and IP3 contains very dated information on earthquake hazards; (2) the application for license renewals for IP2 and IP3 underestimates earthquake hazard ; (3) updated information on instrumentally-recorded earthquakes is vital to assessments of earthquake hazards to Indian Point ; and (4) earthquake risk as well as hazard need to be considered in safety analyses for Indian Point.

4. The report and CV are true and correct to the best of my personal knowledge.

5. Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Dated:

November 29, 2007
Palisades, New York

Lynn R. Sykes

Statement in Support of New York State Contentions and in Response to the April 30, 2007 License Renewal Application Submitted by Entergy for Indian Point Units 2 and 3

by Lynn R. Sykes, Ph.D.

Higgins Professor Emeritus, Earth & Environmental Sciences

Lamont-Doherty Earth Observatory

of Columbia University, Palisades NY 10964

November 29, 2007

Lynn R. Sykes, Higgins Professor Emeritus, Earth & Environmental Sciences at the Lamont-Doherty Earth Observatory of Columbia submits the following statement in support of the contentions submitted by the State of New York in response to the April 30, 2007 license renewal application filed by Entergy Nuclear Operations, Inc., and its corporate affiliates for the Indian Point Power Station located in the Village of Buchanan in Westchester County.

I. The Application for License Renewals for IP2 and IP3 Contains Very Dated Information on Earthquake Hazards

IP3 FSAR Update (2007) Ch. 2.8 lists a table from an unpublished final report on the Indian Point seismic network for the period 1975-1990, but information on earthquakes since 1982, especially that for the Ardsley NY shock of 1985, is not included in either it or IP2 FSAR Update (2007). Table 2.8-1 in that IP3 FSAR Update does not list any earthquakes more recent than 1979. That document also repeats a quote in section 2.8.1 from J. Lynch, who made a study for Indian Point 1 more than 45 years ago, ". . that the probability of a serious shock occurring in this area for the next several hundred years is practically nill [sic]. The area therefore would certainly seem to be as safe as any area at present known." It also quotes him as saying, "estimated maximum ground acceleration of 0.03 g is reasonably conservative for the area." It is not clear from the FSAR Update (2007) for IP1 what design acceleration was used for IP1.

None of the references on earthquakes in Ch. 2 pp. 115-116 of that IP2 FSAR Update are more recent than 1982; only one in IP3 FSAR Update (2007) in Ch. 2.8 (the above unpublished final report) is more recent than 1986. All of these are marked in green as historical information. That Update lists the use of four sets of strong motion data from 1934 to 1952 and on pp. 14 and 15 of Ch. 16 states "no strong motion records were available for the Eastern United States. . ." That statement is very outdated since strong-motion data have existed for the eastern and central United States and Canada for many years as well as for other similar intra-plate regions. Such statement would also appear to be inconsistent with the NRC's recently-initiated analysis of Generic Issue 199 relating to seismic hazards in the central and eastern United States .

II. The Application for License Renewals for IP2 and IP3 Underestimates Earthquake Hazard

A. Can Future Damaging Earthquakes at Indian Point be Excluded?

IP2 FSAR Update (2007) states in both Ch. 1, p. 3 and Ch. 2, p. 1, "Seismic activity in the Indian Point area is limited to low-level microseismicity." The IP2 FSAR Update (2007, Ch. 2, pp. 104-119) includes reference to the Woodward-Clyde Consultants report of 1982 that, in turn, states on p. 113, "Earthquakes occurring near Indian Point have been characterized as shallow focus (<10 km) and low magnitude (1.0-3.0) . . ." While these statements are correct if they refer to the earthquakes during the short period of observations only, they are misleading about the potential for damaging earthquakes at Indian Point according to a broad consensus on how to interpret available data.

Figure 1 is the eastern half of one of several earthquake hazard maps for the United States published and updated periodically by the U. S. Geological Survey (USGS). These maps are derived from the observed earthquake distribution. Figure 1 shows contours of calculated horizontal ground acceleration that would be exceeded with 2% probability in 50 years at a frequency of 5 cycles per second (5 Hz.) for 5% of critical damping. Probabilistic maps of this type are used widely and for building codes and setting insurance rates. Some may argue that critical structures such as bridges, hospitals, and nuclear power reactors should be designed for even higher accelerations and/or less likely exceedance in 50 years. The earthquake hazard map prepared by the USGS (Figure 1) shows that southeastern New York State and northern New Jersey are characterized by a concentration of higher values compared to those of many other areas of the eastern and central United States. Lynch's very old depiction of the Indian Point site as being "as safe as any area at present known" and the repeat of that statement in the IP3 FSAR Update of 2007 clearly are not consistent with the "bulls eye" of higher accelerations in Figure 1, the current USGS earthquake hazard map. Lower values can be seen for central New York State, Michigan, Florida and much of Pennsylvania. Higher values are shown near Charleston, South Carolina, New Madrid, Missouri, and northern New York State and comparable values in southern New Hampshire. Nevertheless, those four areas have much smaller populations and assets at risk than the greater New York City region.

In his discussion of seismic regionalization in the contiguous United States, Richter

(1959) places southeastern New York in a broad region of intensity VIII. He goes on to state "*New York City* should be studied in great detail from the point of view of microregionalization. It is within the range of probable VIII on average ground from a great St. Lawrence earthquake and the shock of 1884 confirms the presence of a local source, probably offshore, also capable of producing VIII." For southeastern New York the USGS probabilistic seismic hazard maps (e.g. Frankel and others, 2005), unlike NRC seismic requirements from the 1970s, contain a contribution to hazard at Indian Point from large earthquakes in the St. Lawrence Valley.

While higher accelerations are calculated by USGS for nearly all of California, nuclear power reactors and other critical structures there are designed for higher accelerations than those at Indian Point. Seismic hazard estimates for some of the first nuclear power reactors in the eastern and central United States, such as that by Lynch, seem to have had in mind a comparison with some of the world's most active earthquake areas, such as those along plate boundaries in Japan, Alaska, Chile, and Peru. By contrast, the eastern two-thirds of United States is an intraplate region of lower, but not negligible, earthquake hazard. The design safe-shutdown acceleration for Indian Points 2 and 3 is 0.15 g. The Diablo Canyon reactors in California were designed for higher accelerations. Seven adjacent nuclear power plants in Niigata prefecture, Japan, were subjected to high accelerations during the earthquake of July 16, 2007 of magnitude 6.6, which occurred nearly beneath them (EERI, 2007). The Niigata reactors were designed for accelerations of only about 0.17 to 0.27g. Four of the observed horizontal accelerations exceeded design values by factors of 2.0 to 3.6. The same plate boundary was the site of the damaging and large Niigata earthquake of 1964 of magnitude, M, 7.5. Even higher accelerations could have occurred if the 2007 earthquake had been as large as that of 1964.

B. Significant Historic Earthquakes and their Relationship to Geologic Terranes

The term microseismicity, as quoted above from the updated FSAR, often is used by seismologists to refer to earthquakes of magnitude smaller than 3.0 (Mogi, 1985, pp. 67-69), which are rarely felt in California and Japan. Many earthquake as small as magnitude 2, however, are routinely felt in the lower Hudson Valley and in northern New Jersey. Shaking of intensities either V or VI has been reported for many earthquakes smaller than M 3.0 (Sykes and others, 2007). Richter (1958, p. 16) states, "*Microseismic* effects are small-scale, observable only with instruments."

Figure 2 indicates that 28 earthquakes of M 3 or greater are known to have occurred in the greater New York City-Philadelphia area. The record for events of M 3.0 is complete since about 1928, that for M 3.5 since about 1840, and that for M 5 and larger since 1737 (Sykes and others, 2007). Several earthquakes larger than M 4.7 in the area of Figure 2 and in nearby Pennsylvania have caused damage. *These events are not microearthquakes.* Their occurrence is, in fact, the basis for the region of higher accelerations in Figure 1 and on other USGS maps of earthquake hazard.

A number of the events in Figure 2 occurred within older hard rocks of the Manhattan Prong, the geologic province in which Indian Point is located. Included are the earthquakes of 1848 of M 4.35, 1985 of 4.1, 1845 of 3.75, 1874 of 3.5, and perhaps the poorly located shock of 1737 of M 5.1. The Reading Prong-western Hudson Highland geologic province is located within a few kilometers of Indian Point and includes earthquakes in 1951 of M 3.85, 2003 of 3.5, 1957 of 3.25 and perhaps two poorly located shocks of 1783 of M 5.1 and 4.65. Most of the other earthquakes in Figure 2 occurred beneath the thin coastal plain sediments of New Jersey and just offshore of New York City in what are inferred to be older hard rocks (Sykes and others, 2007). The Manhattan Prong and the Reading Prong-western Hudson Highland geologic provinces and their associated past earthquake activity are in contact near Indian Point. Farther southwest they are separated by the region of lower activity in Figure 2 beneath the younger and mostly weaker rocks of the Newark basin.

III. Updated Information on Instrumentally-Recorded Earthquakes is Vital to Assessments of Earthquake Hazards to Indian Point

Lamont-Doherty Earth Observatory of Columbia University in conjunction with several local institutions has operated a network of three or more seismograph stations in the greater New York City area since 1962. Coverage by a more extensive network, which has evolved with time, extends from 1974 to the present. Instrumentally-recorded earthquakes from 1974 through 2006 are shown in Figure 3 (for the same area as in Figures 2). Events since 1974 are located more precisely than nearly all of those based solely on intensities (i.e. felt reports of shaking and damage). Furthermore, since 1974 instruments have detected many smaller events, i.e., about 71% of the total known earthquakes from 1677 to 2004 in Figure 4. Consequently, more and better data are available now than approximately 30 years ago when earthquake hazards in the greater New York City region and the earthquake safety of the Indian Point nuclear power plants were first debated.

Instrumental locations are relevant to a finer definition of the distribution of earthquakes than either those shown in Figure 2 or data used to calculate accelerations in Figure 1. Events in Figure 3 are purposely shown free of other geologic information so as to portray the detailed spatial distribution of earthquakes more clearly. For several decades the location capability of the local seismic network was strongest for events in northern New Jersey and southeastern New York State. Coverage south and southwest of New York City in Figure 3 has not been as good.

We find that earthquakes in Figure 3 originate from many faults rather than a few single major faults. Nevertheless, earthquake activity is not distributed uniformly throughout that area, but is concentrated in prominent zones, such as the Ramapo seismic zone (RSZ) in the eastern part of the Reading Prong where station coverage has been strongest since 1974. The southeastern boundary of that 12-km wide zone, which is nearly vertical, extends from near the surface trace of the Mesozoic Ramapo fault to depths of 12 to 15 km. Earthquakes in that zone are occurring within older rocks. Ratcliffe (1980) states that current seismic activity along the Ramapo zone may be more strongly controlled by the presence of through-going crustal structures than it is by more superficial Mesozoic faults. Which faults within the Ramapo seismic zone are active is not clear and remains controversial. Earthquake activity in the Manhattan Prong also extends to depths of 12 to 15 km (Sykes and others, 2007).

A new result based on 34 years of instrumental data is that activity in the Manhattan Prong cuts off abruptly along a nearly vertical, northwest-striking boundary between B and B' in Figure 3 that extends from Stamford Connecticut to Peekskill New York (locations in Figure 4). Activity in Figure 3 is absent to the northeast of that line in the eastern Hudson Highlands. This boundary is sub-parallel to the youngest brittle faults in the Manhattan Prong. One of them, the Dobbs Ferry fault was the site of the 1985 shock of M 4.1. The Peekskill- Stamford seismic boundary is inferred to be a similar and perhaps a more through-going fault or fault zone.

An abrupt bend in the Hudson River to a northwesterly trend is situated near line B-B' (Figure 3), which is close to Indian Point. Fisher et al. (1976) and Ratcliffe (1976) indicate a northwesterly-striking fault on the north side of that segment of the River. An extension of that trend to the northwest follows a major lineament that crosses the Hudson Highlands on the

Preliminary Brittle Structures Map of New York (Isachsen and McKendree, 1977). Most of the seismic activity along the Ramapo seismic zone and the Peekskill-Stamford line appears to end at or near their intersection.

Two well-located events at depths of 15 km are situated at the intersection of the Ramapo seismic zone and the Peekskill-Stamford line just to the northwest of Peekskill near Annsville. Seborowski et al. (1982) conclude that epicenters of a shallow earthquake sequences near Annsville from 1977 to 1980 are aligned northwesterly. That trend indicates that they were situated along a fault or faults at or near the Peekskill-Stamford boundary. Seborowski et al. (1982) and Quittmeyer et al. (1985) of the Woodward-Clyde consulting firm obtained focal mechanism solutions for two small events and composite solutions for two earthquake sequences that occurred within the Indian Point seismic network near Peekskill. The solutions involve a predominance of thrust faulting along nodal planes striking NW to NNW. The strikes of nodal planes of three of those mechanisms are compatible with slip along the Peekskill-Stamford line. These Woodward Clyde studies, however, which appear to have been narrowly focused on the Mesozoic Ramapo fault, were based on a limited data set, and were mostly restricted to the immediate vicinity of Indian Point. They neither reported the Peekskill-Stamford seismic boundary nor considered hazards related to the totality of earthquake activity either near Indian Point or within the Manhattan Prong and the Reading Prong-western Hudson Highlands.

Indian Point is situated at the intersection of the two most striking linear features marking earthquake activity in Figure 3 and also in the midst of a large population that is at risk in case of an accident to the nuclear plants. This is clearly one of the least favorable sites in Figure 3 from an earthquake hazard perspective.

Present knowledge about the state of stress in southeastern New York and northern New Jersey (Sykes and others, 2007) indicates that maximum compression in the crust of the earth is nearly horizontal and is oriented about N64°E (Fig. 2). That orientation can facilitate the occurrence of earthquakes of mainly strike-slip type along brittle faults trending northwesterly, as in the 1985 Ardsley earthquake (Seeber and Dawers, 1989) and along brittle faults oriented about NW to NNW that involving a combination of reverse and strike-slip motion. The mechanisms of Seborowski et al. (1982) and Quittmeyer et al. (1985) for earthquakes near Indian Point are of that type. Ratcliffe (1975, 1976) reported a number of brittle faults in the vicinity of Indian Point, including one "small fault with slickensided surfaces found adjacent (immediately north of) the foundation of reactor 3" that are suitably oriented such that they could be activated in the present stress field.

IV. NRC Staff Responses to Riverkeeper Letter of 2004

The letter from Holden (2004) contains several replies by NRC staff to seismic issues raised earlier in 2004 by Alex Matthiessen, Executive Director, Riverkeeper, Inc. Several of those replies contain much more current information, especially about probabilistic seismic hazard analyses. They state "In response to GL 88-20, Indian Point completed a comprehensive IPEEE review in 1995." That information, however, is not included in the two updated FSARs for Indian Point.

Moreover, several of the responses by the NRC staff to Matthiessen are incorrect. For example, they state "In the area around the Indian Point plant site, there is no evidence to indicate that earthquakes nucleate at unusually shallower depth." To the contrary, depths for several earthquakes near the plants as recorded by the Indian Point network from 1976 to 1983 ranged from as shallow as 1 km to as deep as 12 km (Seborowski et al., 1982; Thurber and Caruso, 1985). Seeber and Dawers (1989) report depths of 4.5 to 5.5 km for aftershocks of the 1985 Ardsley NY earthquake. NRC staff report calculations for a shock of magnitude 5.7 and an historical earthquake of magnitude of 5.2, each at an epicentral distance of 14 km and assumed depth of 10 km. Earthquakes near Indian Point have occurred both closer and shallower than those values.

Another staff response states "It is not possible to determine the rupture lengths of the 1737 and 1884 earthquakes since there are no records to indicate any surface rupture at the time these earthquakes took place." This statement is not correct. It is possible to estimate rupture length from the magnitudes of those events as well as those for the earthquakes of 1783 and 1848 (Fig. 2). This is done routinely by seismologists and earthquake engineers. Few moderate to large earthquakes in the eastern and central North America have involved surface rupture.

V. Earthquake Risk as well as Hazard Need to be Considered in Safety Analyses

Discussions of earthquakes in the updated FSARs consider earthquake *hazard* but not earthquake *risk* to the surrounding regions of high population and assets that could result from damage to one or more of the reactors. Risk as used here (and by USGS and FEMA) is the product of *hazard* times *people or assets* affected times their *vulnerability*. The area of Figures 2 has a lower earthquake *hazard* compared to those of say California and Nevada, but high seismic *risk* that results from the high vulnerability of its built environment and its very high population (Tantala et al. 2003). New York City, Newark, Trenton, and Philadelphia as well as their surrounding highly-populated surrounding areas are situated in Figure 2. The population of that area was 21.4 million in 2005. FEMA (2001) calculated annualized earthquake losses for 40 large U. S. cities using their program HAZUS. They rank New York City 11th in the nation by that measure of *risk* even though it ranks lower in terms of earthquake *hazard.* It is earthquake *risk* that has increased enormously since Henry Hudson sailed up the Hudson River in 1609. Risk is likely to continue to increase if critical facilities such as Indian Point are not better shielded from earthquake hazards in the greater New York City area.

The shock of 1884 of M 5.25 is the largest known event in Figure 2. The front pages of several New York newspapers for the next day were devoted to that earthquake and the damage it caused. Tantala et al. (2003) used HAZUS with a modified building stock for the Metropolitan New York area to estimate losses for earthquakes of magnitude (Mw) 5, 6 and 7 at the site of the 1884 shock as well as probabilistic calculations for average return periods of 100, 500 and 2500 years. For Mw 6 and 7 events at the site of the 1884 shock they calculate losses from buildings and income of $39 billion and $197 billion respectively. Inclusion of infra-structural losses would about double those figures (K. Jacob, personal communication, 2007). Extrapolated repeat times for the area of Figure 2 for events of M 6 and 7 are about 670 and 3400 years (Sykes and others, 2007). The corresponding probabilities of occurrence in a 50-year period are about 7% and 1.5% respectively. The probability of an earthquake the same size as the 1884 event during a 50-year period is about 22%. Probabilistic hazard assessments, such that in Figure 1, rely on extrapolating rates of earthquake occurrence to time periods longer than historic records.

Probabilistic calculations for Indian Point reactors 2 and 3, such as those used by USGS for their national earthquake hazard maps and those now required by NRC for newer nuclear power reactors, need to be debated and evaluated by wide scientific and policy communities. That approach necessitates the inclusion of rates of earthquake activity for periods longer than the historic record, which was not required under the regulations that existed when the Indian Point reactors were originally licensed. If 20-year license extensions are granted, 60 years of operation of the two reactors is a sizable fraction of the 270-year historic record of earthquakes. The chance that the reactors could be shaken by intensities greater than VII and/or subjected to accelerations larger than 0.15 g can be calculated and is not negligible.

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Figure 1

Eastern portion of earthquake hazard map for the conterminous United States (Frankel and others, 2005) prepared by the United States Geologic Service (USGS) showing 2% probability of exceedance in 50 years for horizontal spectral acceleration with period of 0.2 seconds (frequency of 5 cycles per second=5 Hz.). Acceleration is expressed as percent of gravitational acceleration at surface of earth. Note the "bull's-eye" of higher values in New York City, northern New Jersey, and Westchester County, New York, which includes the 3 units at the Indian Point Nuclear Power Station.

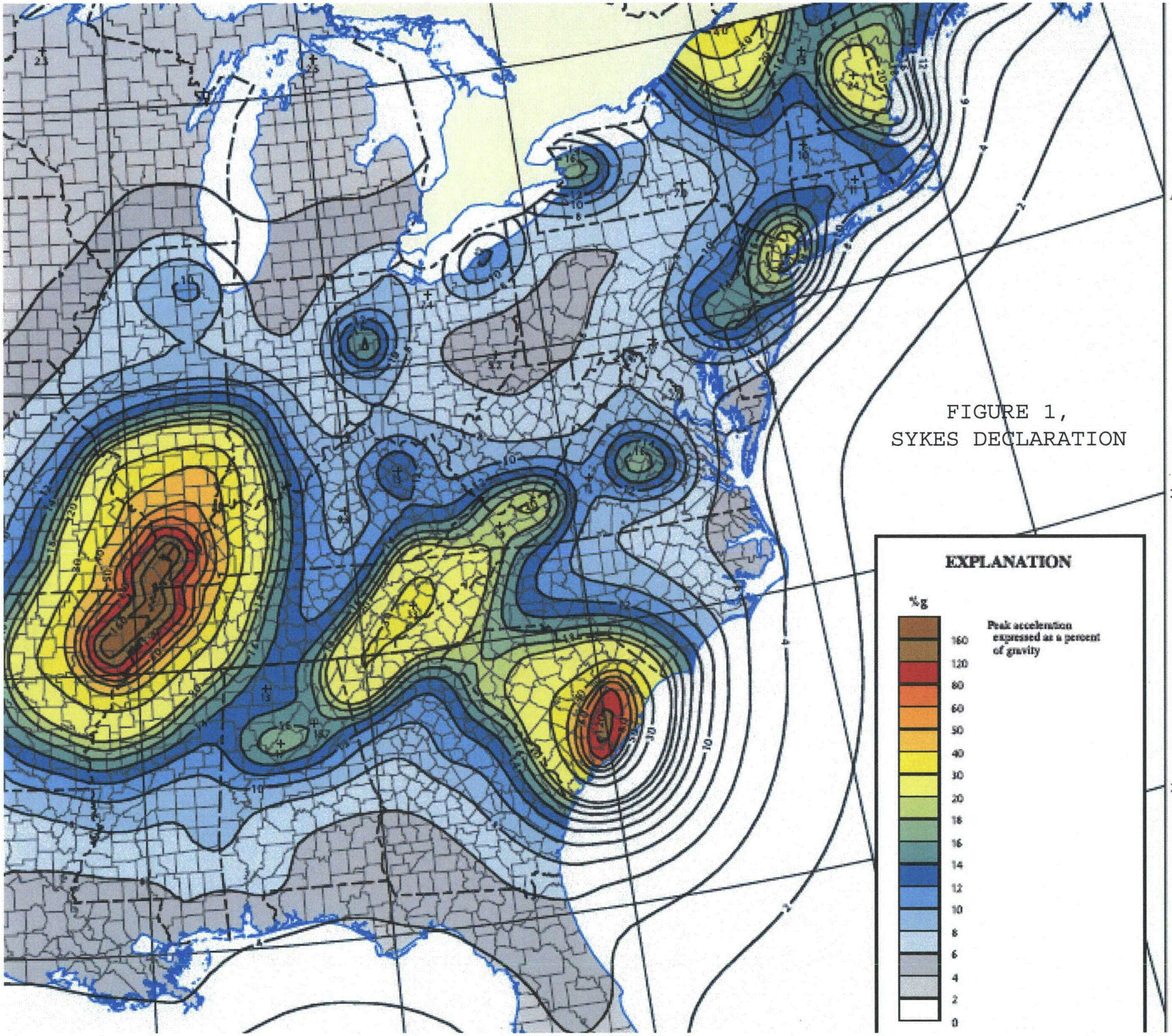


FIGURE 1,
SYKES DECLARATION

Figure 2

Known earthquakes of magnitude $\geq$ 3.0 in the greater New York City-Philadelphia area from 1677 through 2006 (Sykes et al., 2007).

Large "X" denotes Indian Point Nuclear Power Station. Pink denotes Pre-Cambrian rocks; yellow denotes Mesozoic rocks of Newark basin.

Place names: K = Kingston NY, NYC = New York City, PHIL = Philadelphia, N = Newburgh NY, P = Poughkeepsie NY, SI = Staten Island NY, T = Trenton NJ, Wf = Wappinger Falls NY.

Geological features: BV= Buckingham Valley, CL = Cameron's Line, FF = Flemington-Furlong fault, GPS = Green Pond syncline, HF = Hopewell fault, Hud High. = Hudson Highlands, HVF = Huntingdon Valley fault, Man. Prong = Manhattan Prong, NBB = New York Bight basin, SHB = Sandy Hook basin.

Many additional faults in the Reading Prong and short brittle faults in the Manhattan Prong are not shown. Epicenters of large events of 1737 and 1783 may be uncertain by 100 km and are shown as open circles. No events occurred behind legend. Horizontal projections of P axes of better-determined focal mechanisms of earthquakes and directions of maximum horizontal compressive stress from two sets of hydrofracture and one set of borehole breakout experiments are indicated by inward-pointing arrows. The 1957 and 2003 shocks likely occurred at depth in older rocks of the Reading Prong.

FIGURE 2, SYKES DELCARATION

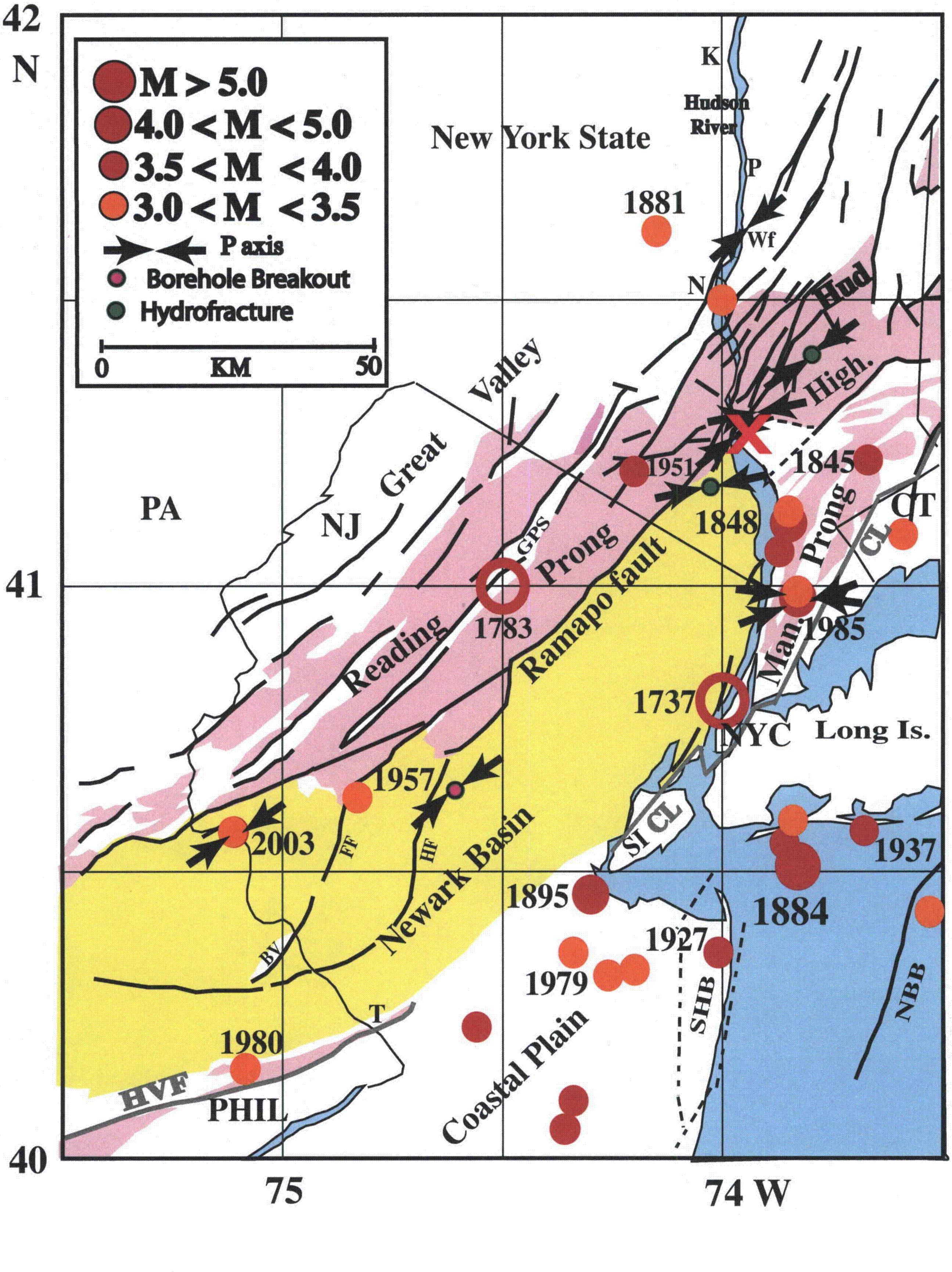


Figure 3

Instrumental locations of earthquakes from 1974 to 2007 (Sykes et al., 2007).

Large "X" denotes Indian Point Nuclear Power Station.

Arrows denote approximate southeastern boundary of Ramapo seismic zone (RSZ) and northwesterly-striking seismic boundary between Stamford CT and Peekskill NY. Pink numerals denote distance along Ramapo zone. Most of the instrumentally-located earthquakes beneath the Newark basin occurred near its northeastern end where its basement shoals.

FIGURE 3, SYKES DECLARATION

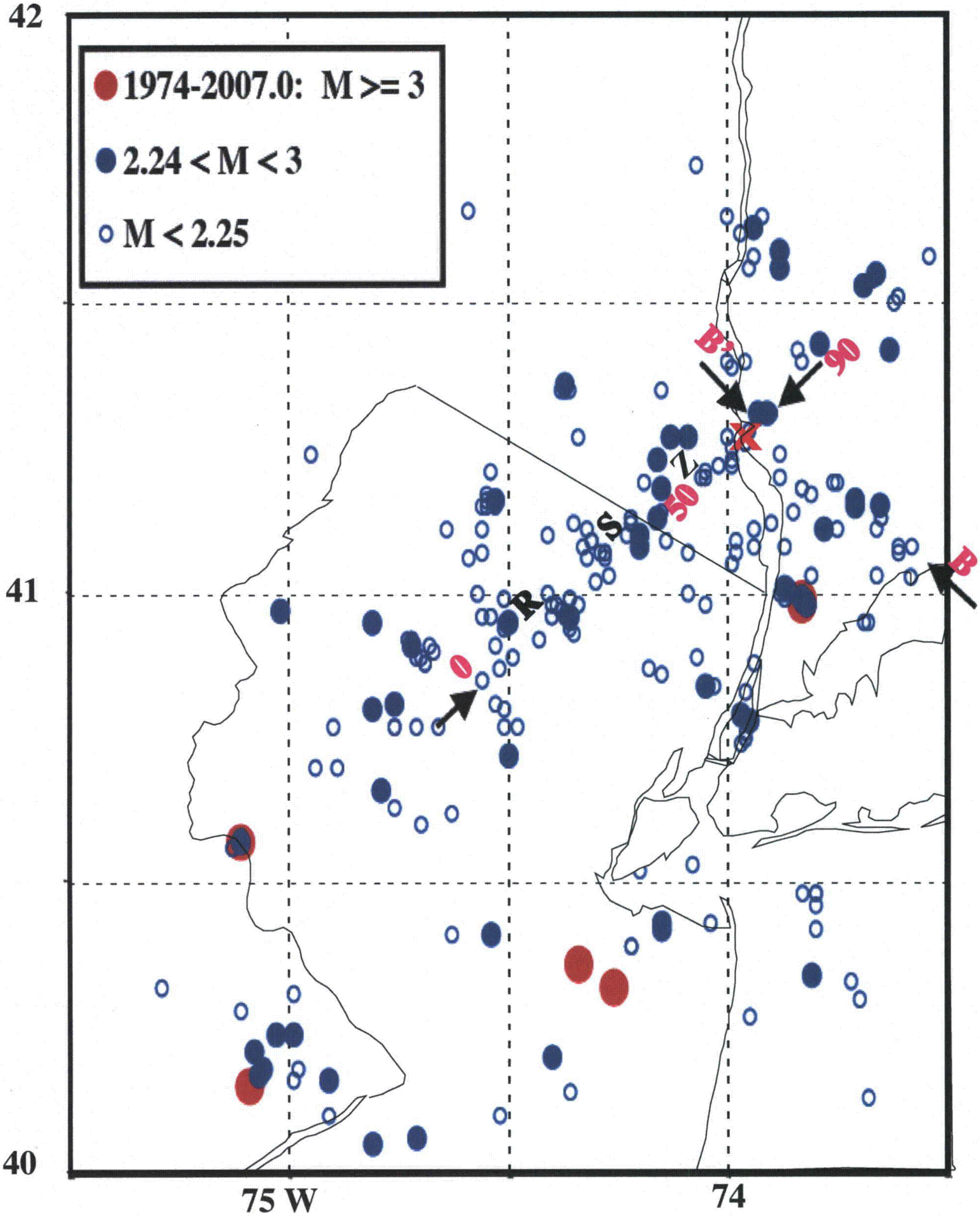


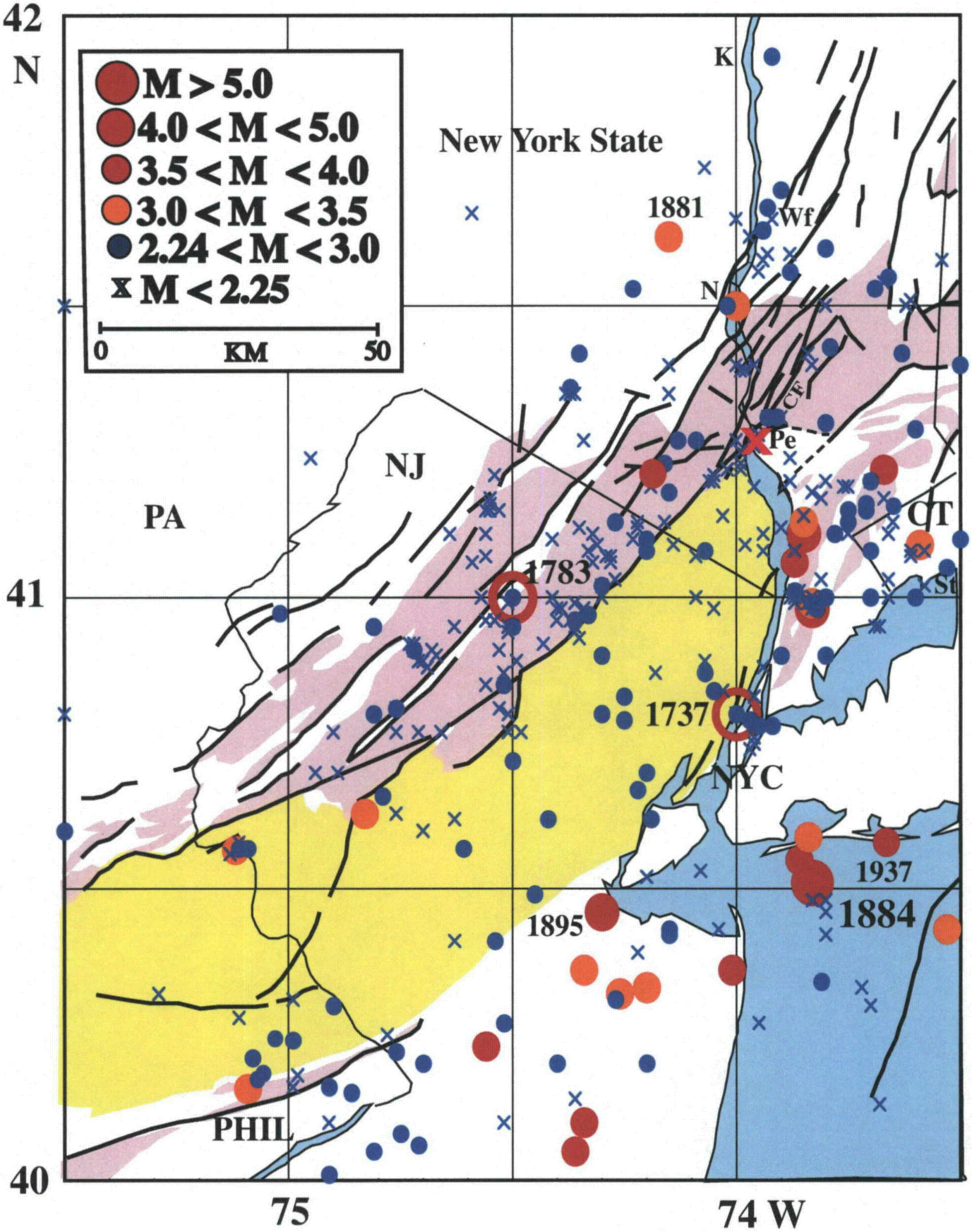
Figure 4

Entire catalog of known earthquakes in greater New York City- Philadelphia area from 1677 through 2004 (Sykes et al., 2007).

Large "X" denotes Indian Point Nuclear Power Station. No events occurred behind legend.

Most of the smaller earthquakes in the Newark basin occurred prior to 1974; many were felt at only a single locality. The population of the basin has long been much higher than that of the Reading Prong-Hudson Highlands. Hence, the record of historic activity in the Newark basin likely over-portrays its rate of microearthquakes activity relative to that of sparsely populated regions. Rock units, faults, magnitudes, open circles and place names same as in Fig. 2. CF = Canopus fault, Wf = Wappinger Falls NY, Pe = Peekskill NY, St = Stamford CT.

FIGURE 4, SYKES DECLARATION



CURRICULUM VITAE

LYNN R. SYKES
April 2007

Birth Date

16 April 1937, Pittsburgh, Pennsylvania

Present Position

Higgins Professor Emeritus of Earth and Environmental Sciences
Columbia University

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Wife

Kathleen Mahoney Sykes

Education

Ph.D., Columbia University in Geology, 1965
Worked under Professor Jack Oliver at Lamont-Doherty Geological Observatory in the field of earthquake seismology.
Dissertation: The propagation of short-period seismic surface waves across oceanic areas.

B.S. and M.S. degrees both awarded by Massachusetts Institute of Technology, Cambridge, MA, Department of Geology and Geophysics, with emphasis on geophysics.

Other areas of concentration: Physics, mathematics, electrical engineering.

Scholarships, Fellowships, Awards, and Honors

Proctor and Gamble Scholarship, M.I.T. for four years as an undergraduate.

Edward John Noble Leadership Award during first three years of graduate study.

Summer Research Fellow, 1959, Woods Hole Oceanographic Institution, Woods Hole, MA.

Fellow of American Geophysical Union, Geological Society of America, Royal Astronomical Society, American Association for Advancement of Science, Geological Society (London).

H.O. Wood Award in seismology from Carnegie Institution of Washington for research in geologic aspects of seismology: $10,000, 1967-1970.

Associate Editor, Journal of Geophysical Research, 1968-1970.

Sloan Fellow, 1969-1971.

Presented Frontiers in Geophysics paper "The New Global Tectonics" before 50th Anniversary Meeting of American Geophysical Union, April 1969.

President of Geological Section, New York Academy of Sciences, 1970-1971.

Macelwane Award to outstanding young geophysicist for 1970 by American Geophysical Union.

President of Section on Tectonophysics of American Geophysical Union, 1972-1974.

Walter H. Bucher Medal of the American Geophysical Union for "original contribution to the basic knowledge of the earth's crust", 1975.

Elected to U.S. National Academy of Sciences, 1979.

Chosen as Higgins Professor of Geology, Columbia University, 1978.

Work on Plate Tectonics included in the exhibit, "Creativity -- The Human Resource", California Academy of Sciences, San Francisco, April-May 1979.

Elected to American Academy of Arts and Sciences, 1979.

Sherman Fairchild Distinguished Scholar, California Institute of Technology, 1981.

Visiting Fellow, Clare Hall, Cambridge University, Spring 1982.

President-Elect of Section on Seismology, American Geophysical Union, 1982-1984; President 1984-1986.

Public Service Award for 1986 from Federation of American Scientists (along with Jack F. Evernden and Charles Archambeau) for "leadership, effectiveness, and courage in the application of seismology to the banning of nuclear tests, through public education and bureaucratic struggles".

Honorary Doctoral Degree by the State University of New York at Potsdam, May 1988.

Fellowship, John Simon Guggenheim Memorial Foundation, October 1, 1988-June 30, 1989.

John Wesley Powell Award by the U.S. Geological Survey for service to U.S. earthquake program, May 1991.

Finalist, Mayor of New York City's Award for Excellence in Mathematical, Physical and Engineering Sciences, 1992.

Medal of Seismological Society of America, March 1998.

Vetlesen Prize, for "achievement in the sciences resulting in a clearer understanding of the earth, its history or relation to the universe" January 24, 2000

Scientific Research

Scientific research includes investigations of long-period and mantle seismic waves (1961-1962); surface wave propagation across ocean areas (1961-1964); precise location of earthquake hypocenters and relationship of spatial distribution of earthquakes to large-scale tectonic phenomena (1962-); seismicity of island arcs, mid-ocean ridges, and fracture zones (1963-); field study of aftershocks of 1964 Alaskan earthquake (1964); field study of deep and shallow earthquakes in Fiji-Tonga region (1966); spatial and temporal distribution of major earthquakes and major aftershock series (1965-); field study of microearthquakes in Iceland (1968); earthquake prediction (1967-); seismology and the new global tectonics (1968-1975); field study of Denali fault, Alaska (1967); field study of microearthquakes in Nevada and in Puerto Rico - Virgin Islands region (1969); discrimination between earthquakes and underground explosions and implications for a nuclear test ban treaty (1962-); seismicity and the tectonics of eastern North America (1969-1985); state of stress in the interiors of plates and intraplate earthquakes (1969-1980, 1994-); seismicity, tectonics and earthquake prediction in Puerto Rico and Virgin Islands (1974-1984); spatial and temporal variations of seismicity in California (1981-); nuclear arms control (1970-); seismic safety of nuclear power plants and their spent fuel pools (2004-).

Employment

Present Status: Higgins Professor Emeritus of Earth and Environmental Sciences, Columbia University.

Head of Seismology Group (1973-1983)

Earth Sciences Laboratories, Environmental Science Services Administration, Department of Commerce as Research Geophysicist; Adjunct Professor of Geology, Columbia University, June 1966-August 1968. GS 14.

Lamont-Doherty Geological Observatory of Columbia University; Research Associate in Seismology, 1964-1966. Research Assistant, 1961-1964.

Woods Hole Oceanographic Institution, Woods Hole, MA, Summers of 1959 and 1960, research in marine geophysics, included participation in scientific cruises in Atlantic and Mediterranean. Master's thesis in conjunction with M.I.T. -- "Correlation of Physical Properties of Deep-Sea Sediments with Sea-Bottom Reflections."

U.S. Geological Survey, Geophysical Laboratory, Silver Spring, MD, summer of 1956 as physical science aide. Studied consolidation of calcium carbonate muds with E.C. Robertson and M. Newell.

Professional Societies

Seismological Society of America, American Geophysical Union, Royal Astronomical Society, Geological Society of America, New York Academy of Sciences, Geological Society of London, U.S. National Academy of Sciences, American Academy of Arts and Sciences, Arms Control Association, Federation of American Scientists. Originated ideas of forming Southern California Earthquake Center and Alaskan Volcano Center.

Scientific Committees and Advisory Boards

Polar Geophysics Panel of National Academy of Science (1968).

Advisory Committee of National Academy of Sciences to ESSA Research Laboratories on solid earth geophysics (1968-1969).

NASA Geodesy and Cartography Subcommittee of Space Science and Applications Steering Committee (1968-1970).

NAS/NRC Committee on World-Wide Standardized Seismograph Network (1969).

Organizing Secretary: International Symposium on Mechanical Properties and Processes of the Mantle, sponsored by International Upper Mantle Committee (1970).

Member Board of Directors of Seismological Society of America (1968-1972).

Member JOIDES panel on Deep Crustal Drilling in Marine Areas (1970-1971).

Member of U.S. Geodynamics Panel on Mid-Atlantic Ridge (1971-1972).

Committee on Seismology of National Academy of Sciences/National Research Council (1972-1975).

Testified before U.S. Senate Foreign Relations Committee, Subcommittee on Arms Control, International Law and Organization on Hearings on Comprehensive Test Ban Treaty, May 15, 1972.

Advisor to New York State Geological Survey and New York State Environmental Protection Agency on Earth Hazards Related to Fluid Injection (1970-1974).

Chairman of Search Committee for Director of Lamont-Doherty Geological Observatory, 1972.

Member of Vetlesen Award Committee, Columbia University (1972-1985).

Member of Executive Committee (1973-1977) and Advisory Board (1973-1981; 1999-) Lamont-Doherty Geological Observatory of Columbia University. Chairman of Advisory Board (1975-1981).

Panel on Earthquake Prediction, National Academy of Sciences/National Research Council (1973-1976).

Advisory Committee on Proposals for Earthquake Prediction, U.S. Geological Survey (1974).

Member of Working Group, U.S./U.S.S.R. Joint Program for Earthquake Prediction (1973-1978).

Member U.S. Technical Delegation for talks on treaty on Threshold Limitations of Underground Nuclear Explosions, Moscow, June-July 1974.

National Science Foundation Earth Science's Review Panel (1974-1977).

U.S. Geodynamics Committee, study groups on plate interiors and Cocos and Caribbean plates.

Member of U.S. Delegation on Earthquake Prediction during visit to U.S.S.R., October 1973.

Member of U.S. Seismology Group for visit to People's Republic of China, October - November, 1974.

Visiting Professor, Earthquake Research Institute of Tokyo University, November-December 1974.

Nominations Committee on Fellows for American Geophysical Union, 1975, and Committee on Publications 1975-1976. Committee for Bucher Medal, 1977, Committee for Bowie Medal, 1986-87, Chair, Bucher Medal, 2001.

Consultant and expert witness for New York State and for Citizen's Committee for the Protection of the Environment involving seismologic and geologic safety of Indian Point Nuclear Power Reactors, New York, 1975-1976.

Review committee for U.S. Federal Government program on Earthquake Prediction and Hazards Reduction under President's Science Advisor, Dr. H. Guyford Stever (1976).

Planning committee for Chapman Conference on "State of Stress in the Lithosphere", Aspen, Colorado, 1976.

U.S. Air Force -- AFTAC -- panel on seismic determination of yield of underground nuclear explosions, 1974-1977.

Defense Science Board -- panel on yields of underground nuclear explosions, 1977.

Committee on award of Day Medal -- Geological Society of America, 1974-1976; Penrose Medal, 1977-1978.

Member Seismological Panel, Office of Science & Technology Policy, Executive Office of the President, September 1 & 2, 1977.

Member USGS Earthquake Studies Advisory Panel, 1977-1981.

Member Columbia University Commission on Academic Priorities in the Arts and Sciences, 1978-1979.

Testified about Seismic Risk to Indian Point, NY, Nuclear Power Plants before Advisory Committee on Reactor Safety, U.S. Nuclear Regulatory Commission, June 16, 1978.

Member Search Committee for Director of New York State Geological Survey, 1978.

Chairman, Panel of Public Policy Regarding Prediction of Earthquakes, American Geophysical Union, 1979-1980.

Lecturer, NATO Summer Institute on "State of Stress in the Earth's Lithosphere", June 1979.

Convenor, Ewing Symposium on Earthquake Prediction, May 12-16, 1980.

Member Earthquake Prediction Evaluation Council, U.S. Geological Survey, 1979-1982.

Chairman of Search Committee for Director of Lamont-Doherty Geological Observatory, 1981.

Lecturer, NATO Summer School on Earthquake Risk, Guadeloupe, August 1983.

Member Advisory Panel on Seismology, Defense Advanced Research Projects Agency, 1983-1988.

Co-organizer of symposium "Verification of Nuclear Test Ban Treaties", with Dr. Jack Evernden, American Geophysical Union, Baltimore, MD, June 1983.

Co-organizer of interdisciplinary course for undergraduates "The Nuclear Arms Race", Columbia College, 1984, 1985.

Member, Columbia University Seminar on Arms Control, 1984-1996.

Chairman, National Earthquake Prediction Evaluation Council (NEPEC), U.S. Geological Survey, Fall 1984-Summer 1988.

Participant in NOVA television program "Spacebridge to Moscow", October 2, 1984.

Member of Expert Review Committee for Evaluation of National Earthquake Hazards Reduction Program, 1987.

Member of the Advisory Panel to Natural Resources Defense Council on Seismic Stations in the Soviet Union, 1986-1988.

Member of Seismic Verification Advisory Panel, Office of Technology Assessment, U. S. Congress, 1986-1987.

Seismology Seminar Course at Columbia University on Verification of Nuclear Test Ban Issues, with Paul G. Richards, Fall 1987 semester.

Participant, Belmont Conference on Nuclear Test Ban Policy, Fall 1988.

Member of U.S. National Committee for the Decade for Natural Hazards Reduction, National Academy of Sciences, National Reseaarch Council, 1989-1990.

Participant in NOVA program "Earthquake", 1990.

Invited Speaker, Princeton Symposium on Non-Proliferation and Nuclear Testing, Nov. 1992.

Co-Organizer, All Union Symposium on Verification of Treaties to Limit the Testing and Proliferation of Nuclear Weapons, American Geophysical Union Spring Meeting, May 27, 1993.

Invited talk "Earthquake Prediction", regional meeting of National Academy of Sciences, at Columbia University, Fall 1996.

Invited talk "Earthquake Prediction: What is Possible and what is Unknowable", Columbia Graduate students in science, April 9, 1997.

Co-organizer, symposium on "Earthquake Stress Triggers, Stress Shadows, and their Impact on Seismic Hazard", Menlo Park, CA, March 21-22, 1997.

Co-organizer, symposium on "Earth Systems Predictability: The Unknown and Unknowable", Santa Fe Institute Workshop, November 6-8, 1997.

Head, Natural Hazards Initiative, Lamont-Doherty Earth Observatory, 1998-99

Co-Organizer, All Union Symposium on Verification of Comprehensive Nuclear Test Ban Treaty, American Geophysical Union, Spring Meeting, May 31, 2000.

Testified in 2000 before Arms Control Advisory Board, U. S. State Dept., Jason group, Stanford-Lawyers Alliance for World Security, National Academy of Sciences/National Research Council Committee on Comprehensive Nuclear Test Ban Treaty.

Board of Directors, Federation of American Scientists, 2000-2003; also on their panel on CTBT.

American Geophysical Union, Chair Bucher Award, Fall 2001

PUBLICATIONS

1961 Sykes, L.R., E.C. Robertson, and M. Newell, Experimental consolidation of calcium carbonate sediment, in Environment of Calcium Carbonate Deposition West of Andros Island Bahamas, by P.E. Cloud, Jr., U.S. Geol. Surv. Prof. Paper 350.

1962 Sykes, L.R., M. Landisman, and Y. Sato, Mantle shear wave velocities determined from oceanic Love and Rayleigh wave dispersion, J. Geophys. Res., 67, 5257-5271.

1963 Sykes, L.R., Seismicity of the South Pacific Ocean, J. Geophys. Res., 68, 6006-6999.

1964 Sykes, L.R., and J. Oliver, The propagation of short-period seismic surface waves across oceanic areas, Part I -- Theoretical study, Part II -- Analysis of Seismograms, Bull. Seismol. Soc. Am., 54, 1349-1415.

1964 Sykes, L.R., and M. Landisman, The seismicity of East Africa, the Gulf of Aden, and the Arabian and Red Seas, Bull. Seismol. Soc. Am., 54, 1927-1940.

1964 Sykes, L.R., Deep-focus earthquakes in the New Hebrides region, J. Geophys. Res., 69, 5353-5355.

1965 Sykes, L.R., The seismicity of the Arctic, Bull. Seismol. Soc. Am., 55, 536-591.

1965 Sykes, L.R., and M. Ewing, The seismicity of Caribbean region, J. Geophys. Res., 70, 5065-5074.

1966 Tobin, D.G., and L. R. Sykes, Relationship of hypocenters of earthquakes to the geology of Alaska, J. Geophys. Res., 71, 1659-1667.

1966 Sykes, L.R., Spatial and temporal distribution of earthquakes, in ESSA Symposium on Earthquake Prediction, pp. 38-43, U.S. Dept. of Commerce, Washington, D.C.

1966 Sykes, L.R., Seismicity and deep structure of island arcs, J. Geophys. Res., 71, 2981-3006.

1967 Sykes, L.R., Mechanism of earthquakes and nature of faulting on the mid-Oceanic ridge, J. Geophys. Res., 72, 2131-2153.

1967 Isacks, B.L., L.R. Sykes, and J. Oliver, Spatial and temporal clustering of deep and shallow earthquakes in the Fiji-Tonga-Kermadec region, Bull. Seismol. Soc. Am., 57, 935-958.

1967 Sykes, L.R., Seismicity, Trans.,AGU, 48, 389-395. A portion of U.S. National Report to the 14th General Assembly of I.U.G.G.

1968 Sykes, L.R. Seismological evidence for transform faults, sea-floor spreading and continental drift, in History of the Earth's Crust, Princeton Univ., edited by R.A. Phinney, pp. 120-150.

1968 Tobin, D.G., and L.R. Sykes, Seismicity and tectonics in the northeast Pacific Ocean, J. Geophys. Res., 73, 3821-3845.

1968 B.L. Isacks, J. Oliver, and L.R. Sykes, Seismology and the new global tectonics, J. Geophys. Res., 73, 5855-5899, also Tectonophysics, 7, 527-541, 1969.

1968 Sykes, L.R., Deep earthquakes and rapidly-running phase changes, a reply to Dennis and Walker, J. Geophys. Res., 73, 1508-1510.

1969 Banghar, A., and L.R. Sykes, Focal mechanisms of earthquakes in the Indian Ocean and adjacent regions, J. Geophys. Res., 74, 632-649.

1969 Sykes, L.R., B.L. Isacks, and J. Oliver, Spatial distribution of deep and shallow earthquakes of small magnitudes in the Fiji-Tonga region, Bull. Seismol. Soc. Am., 59, 1093-1113.

1969 Molnar, P., and L.R. Sykes, Tectonics of the Caribbean and Middle America regions from focal mechanisms and seismicity, Bull. Geol. Soc. Am., 80, 1639-1684.

1969 Molnar, P., K. Jacob, and L.R. Sykes, Microearthquake activity in eastern Nevada and Death Valley, California before and after the nuclear explosion Benham, Bull. Seismol. Soc. Am., 59, 2177-2184.

1969 Sykes, L.R., Seismicity of mid-Oceanic ridge system, in The Earth's Crust and Upper Mantle, Geophysical Monograph, 13, Am. Geophys. Union, Washington, D.C., P.J.Hart, editor, pp. 148-153.

1969 Molnar, P., J. Savino, L.R. Sykes, R.C. Liebermann, G. Hade, and P.W. Pomeroy, Small earthquakes and explosions in western North America recorded by new high-gain, long-period seismographs, Nature, 224, 1268-1273.

1969 Katsumata, M., and L.R. Sykes, Seismicity and tectonics of the western Pacific: Izu-Mariana-Caroline and Ryukyu-Taiwan regions, J. Geophys. Res., 74, 5923-5948.

1969 Isacks, B.L., L.R. Sykes, and J. Oliver, Focal mechanisms of deep and shallow earthquakes in the Tonga-Kermadec region and the tectonics of island arcs, Bull. Geol. Soc. Am., 80, 1443-1470.

1970 Sykes, L.R., Seismicity of the Indian Ocean and a possible nascent island arc between Ceylon and Australia, J. Geophys. Res., 75, 5041-5055.

1970 Sykes, L.R., Focal mechanism solutions for earthquakes along the world rift system, Bull. Seismol. Soc. Am., 60, 1749-1752.

1970 Murphy, A., L.R. Sykes, and T.W. Donnelly, Preliminary survey of the microseismicity of the northeastern Caribbean, Bull. Geol. Soc. Am., 81, 2459-2464.

1970 Sykes, L.R., Earthquake swarms and sea-floor spreading, J. Geophys. Res., 75, 6598-6611.

1970 L.R. Sykes, R. Kay, and O. Anderson, Mechanical properties and processes in the mantle: a review of upper mantle symposium in Flagstaff, Arizona, EOS, Trans. Amer. Geophys. Union, 51, 874-879.

1971 L.R. Sykes, J. Oliver, and B.L. Isacks, Earthquakes and tectonics, The Sea, Vol. 4, A.E. Maxwell, editor, John-Wiley Interscience, 354-420.

1971 Molnar, P., and L.R. Sykes, Plate tectonics and the Hispaniola area: Discussion, Bull. Geol. Soc. Am., 82, 1123-1126.

1971 Sykes, L.R., Review of recent research at Columbia University on the discrimination of underground explosions from earthquakes, in copies of papers presented at Woods Hole Conference on Seismic Discrimination, 20-23 July 1970, Advanced Research Projects Agency, 19 pages.

1971 Sykes, L.R., Aftershock zones of great earthquakes, seismicity gaps, earthquake prediction for Alaska and the Aleutians, J. Geophys. Res., 76, 8021-8041.

1971 Savino, J., L.R. Sykes, R.C. Liebermann, and P. Molnar, Excitation of seismic surface waves with periods of 15 to 70 sec for earthquakes and underground explosions, J. Geophys. Res., 76, 8003-8020.

1971 Evernden, J.F., W. Best, P.W. Pomeroy, T.V. McEvilly, J.M. Savino, and L.R. Sykes, Discrimination between small magnitude earthquakes and explosions, J. Geophys. Res., 76, 8042-8055.

1972 Sykes, L.R., Seismicity as a guide to global tectonics and earthquake prediction, A.R. Ritsema (editor), The Upper Mantle, Tectonophysics, 13, 1-4.

1972 Sbar, M.L., and L.R. Sykes, Contemporary compressive stress and seismicity in eastern North America: An example of intra-plate tectonics, Bull. Geol. Soc. Am, 84, 1861-1882.

1972 Kelleher, J., L.R. Sykes, and J. Oliver, Possible criteria for earthquake locations and their application to major Pacific plate boundaries, J. Geophys. Res., 78, 2547-2585.

1972 Savino, J., A.J. Murphy, J.M.W. Ryan, R. Tatham, L.R. Sykes, G.L. Choy, and K. McCamy, Results from the high-gain long-period seismograph experiment, Geophys. J., 31, 179-203.

1972 Sykes, L.R., and D. Hayes, Seismicity and tectonics of South America and adjacent oceanic areas, Abst. with Programs ,67th Annual Meeting, Geol. Soc. Am., 1971.

1972 Sykes, L.R., Testimony before U.S. Senate Foreign Relations Committee, Subcommittee on Arms Control, International Law and Organization, Hearings on Comprehensive Nuclear Test Ban Treaty, published remarks by L.R. Sykes, pp. 53-56, May 15, 1972.

1973 Aggarwal, Y., L.R. Sykes, J.G. Armbruster, and M.L. Sbar, Premonitory changes in seismic velocities and prediction of earthquakes, Nature, 241, 101-104.

1973 Scholz, C.H., L.R. Sykes, and Y.P. Aggarwal, Earthquake prediction: A physical basis, Science, 181, 803-810.

1973 Sykes, L.R., and M.L. Sbar, Intraplate earthquakes, lithospheric stresses and the driving mechanism of plate tectonics, Nature, 245, 298-302.

1973 Scholz, C.H., L.R. Sykes, and Y.P. Aggarwal, The physical basis for earthquake prediction, Kagaku, 43, 541-549.

1974 Sykes, L.R., and M.L. Sbar, Focal mechanism solutions of intraplate earthquakes and stresses in the lithosphere, in Geodynamics of Iceland and the North Atlantic Area, L. Kristijansson, ed., 207-224, Reidel Publ. Co., Holland.

1975 Aggarwal, Y.P., L.R. Sykes, D.W. Simpson, and P.G. Richards, Spatial and temporal variations in t_s/t_p and P-wave residuals at Blue Mountain Lake, New York: Application to earthquake prediction, J. Geophys. Res., 80, 718-732.

1975 Sykes, L.R. Earthquake prediction: Learning to spot the warnings, a viewpoint, in Encounter with the Earth, by Leo F. Laporte, pp. 491-494, Canfield, Press, San Francisco.

1975 Sykes, L.R., Earthquake research in China, with members of the seismological delegation to the People's Republic of China, EOS, Trans. Amer. Geophys. Union, 56, 838-881.

1976 Tatham, R., D. Forsythe, and L.R. Sykes, The occurrence of anomalous seismic events in eastern Tibet, Geophys. J., 45, 451-481.

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Mendiola, Doris

From:	Janice Dean [Janice.Dean@ag.ny.gov]
Sent:	Tuesday, January 12, 2010 1:17 PM
To:	Rulemaking Comments
Cc:	Janice Dean; John Sipos; Teresa Fountain
Subject:	Re: State of New York comments, RIN 3150-AI42 [NRC-2008-0608]
Attachments:	Ex H - Seeber declaration.pdf

Attached please find Exhibit H to the State's comments, the State's final exhibit.

Please contact me with any questions concerning this transmittal, which is now complete. Thank you.

Janice Dean

>>> Janice Dean 1/12/2010 1:02 PM >>>
Dear Rulemakings and Adjudications Staff,

Attached please find the State of New York's comments on the NRC's Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses. Exhibits will follow in subsequent emails due to their size.

Please contact me with any questions concerning this transmittal. Thank you.

Janice Dean

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

---x

In re:

License Renewal Application Submitted by

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

---x

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

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

DPR-26, DPR-64

DECLARATION OF LEONARDO SEEBER

Leonardo Seeber hereby declares under penalty of perjury that the following is true and correct:

1. I am currently a senior research scientist at the Lamont-Doherty Earth Observatory of Columbia University. I have served as a research scientist at Lamont Doherty since 1972. I received a B.S. in Nuclear Engineering from Columbia University in 1965.

2. During the course of my career, I have studied earthquake related issues in the New York City Seismic Zone (which includes portions of New York State, New Jersey, Pennsylvania, and Connecticut) and throughout the United States and the world. My CV is attached to this declaration.

3. I have prepared a report concerning the earthquake activity in intraplate continental regions such as eastern North America, with emphasis on issues directly relevant to earthquake hazard in the greater tri-state New York City Seismic Zone and the area in and around the site for the Indian Point Nuclear Power Station.

4. The report and CV are true and correct to the best of my personal knowledge.

5. Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Dated:

November 29, 2007
Palisades, New York

Leonardo Seeber

Leonardo Seeber presents the following report in connection with the application to renew the operating licenses for the Indian Point Nuclear Power Station for an additional 20 years.

Premise

These comments summarily characterize earthquake activity in intraplate continental regions such as eastern North America, with emphasis on issues directly relevant to earthquake hazard in the greater tri-state New York City seismic zone (NYCSZ) and at the Indian Point site. The last three decades have witnessed substantial improvements in knowledge about earthquakes and their relation to geologic features. This progress includes generalities about intraplate areas, where earthquake activity and geologic processes are relatively subdued, as well as specifics about the NYCSZ. Particularly relevant are differences in understanding between the present and the time Indian Point 3 was licensed. Some of these differences would unambiguously increase the estimated hazard at Indian Point.

In New York City seismic zone, which includes the site for the Indian Point Nuclear Power Station, some of the earthquakes occur at mid-crustal depths, but many reliable earthquake hypocenters show that very shallow earthquakes predominate in the New York City Seismic Zone including the area around Indian Point.

Furthermore, many of the larger earthquakes in the NYCSZ during the last three decades have occurred on northwest-striking faults. These faults are small relative to the Ramapo and other northeast-striking faults, but form a distinct family of faults that generally cut and are therefore younger than other faults. One of these faults has been mapped 5 km north of Indian Point and maybe related to a nearby earthquake sequence that occurred during 1977-1980.

Generally, earthquake activity and tectonics along active plate-boundaries and in intraplate zones were thought to differ in rate, but otherwise to stem from the same fundamental process and thus to resemble one another qualitatively. Improved observations and understanding has revealed distinctions in both the spatiotemporal distribution of earthquakes and their source characteristics. These differences affect algorithms used to derive ground motion from earthquake parameters and thus have important implications for hazard. The scope of these comments, however, is strictly qualitative. It does not include any evaluation of the hazard, nor a sensitivity analysis to evaluate the effects on the hazard of specific aspects of intraplate earthquake generation, as they are now understood.

**Intraplate Eastern North America and
The New York City Seismic Zone**

Eastern North America is a continental area fully contained within the North American plate. This intraplate area is one of the more thoroughly studied from geological and seismological viewpoints. During the historic period earthquakes have occurred over most of this area, although epicenters are more concentrated in specific zones. Widespread earthquake activity is consistent with stress measurements, which show that the stress in the upper crust of intraplate continental areas is generally high and near failure (e.g., Zoback and Zoback, 1989). Each earthquake manifests fault rupture and slip and thus contributes to deformation of the Earth's crust. Deformation events associated with earthquakes are generally coherent over eastern North America and cause shortening in an east-northeast direction (Sbar and Sykes, 1973). The rate of this deformation has been calculated from the earthquake activity (Anderson, 1986). This rate is slower than can be resolved with current geodetic measurements but is significant when applied over geologic time scales. The accumulated effects of this intraplate strain have been associated with widespread geologic structures (e.g., Sbar and Sykes, 1973), but these structures are generally subtle and rarely include geologic evidence of fault slip that could be associated with specific intraplate earthquakes, such as the surface rupture associated with 1990 earthquake in Ungava, northern Quebec (Adams et al. 1991). Thus geologists have described eastern North America and similar intraplate areas as "stable continental regions" (SCR). The combination of widespread intraplate earthquake activity and lack of obvious geologic strain is still generally astonishing and is the subject of ongoing research (further discussed below). This geologic 'stability', however, should not mislead regarding intraplate earthquake activity, which is observed, has caused damage, and will likely continue to do so. Geologic stability was clearly a factor a few decades ago in the debate about earthquake hazard at Indian Point. The apparent geologic stability in the area around Indian Point was contrasted with the obvious geologic activity along plate boundaries such as the San Andreas fault zone in California. More useful is a comparison with other intraplate areas that display similar 'stability', yet have experienced large and destructive earthquakes (e.g., Coppersmith and Joungs, 1989; Jonston, 1989).

The greater New York City metropolitan area correlates with a seismic zone (NYCSZ), a concentration of earthquake activity that stands out in the field of epicenters over eastern North America. Geologically, the NYCSZ is associated with the Newark Basin (Figure 2), a feature formed during the opening of the Atlantic Ocean in the Mesozoic era. Earthquakes are concentrated in older rocks that outcrop around the basin, from Reading, Lancaster, and Philadelphia PA, to Peakskill NY and from Westchester and New York City to the Hudson Highlands and the lower Hudson Valley. The NYCSZ is one of several zones of concentrated earthquake activity in eastern North America that have persisted through the historic period, and have been documented by both early felt and damage reports as well as by current instrumental data (e.g., Hough et al., 2003). Some of these zones have experienced very large earthquakes ($M \geq 7$) that caused damage, such as the 1886 Charleston SC earthquake, or would have caused much more damage had they occurred later, such as the 1811-12 New Madrid MO earthquakes. Other earthquake zones, such as the ones in eastern Tennessee and the NYCSZ have generated intermediate-size earthquakes with relatively minor consequences during the historic period, but are thought to be capable of producing larger earthquakes. The absence from the record of the largest possible earthquakes in these areas is accounted for by average recurrence times likely to be substantially longer than the historic period (e.g., Seeber and Armbruster. 1991).

Relation of intraplate earthquakes to observable faults

In tectonically active regions, such as the San Andreas plate boundary in California, damaging earthquakes occur on faults that can be independently recognized as being active from their displacement characteristics. Slip rate can often be measured directly along the surface trace of faults or assessed indirectly by the rate of growth of fault-related folds. Thus geologic data on faults and their slip behavior can be used to assess the earthquake potential in these areas independently of earthquake data. A fault in California that displays evidence of no geologically recent displacement, during the last tens to hundreds of thousand years, is usually insignificant for earthquake hazard. Early attempts at characterizing intraplate earthquake hazard applied this geologic approach seeking to identify key faults responsible for most of the earthquakes. Past rupture behavior of these faults would then offer strong geologic constraints on future earthquake activity (e.g., Crone et al., 1992). Many geologic studies of the source areas following intraplate earthquakes, however, have dashed these hopes (e.g., NRC Regulatory Guide 1.208, p. 6, 2007).

Most of the large intraplate earthquakes (M≥6) worldwide are in the shallow part of the crust (Figure 1). Not surprisingly, these large shallow earthquakes tend to rupture the surface (Table 1), thus unequivocally identifying the causative fault and offering opportunities for geologic studies of these faults. After they ruptured in M≥6 earthquakes, these faults are declared active. Had those fault been studied before the earthquakes, however, they would probably not have been considered active, because they often showed no sign of having ruptured during the previous hundred thousand years or much longer (e.g., Crone et al., 1992; Machette et al., 1993; Adams et al., 1991; Seeber et al., 1996). Accumulated displacements on some of the faults that produced significant earthquakes in the NYCSZ were remarkably small and allowed for no more than a few surface-rupturing earthquakes during prior time those faults existed in an intraplate regime (e.g., Seeber and Dawers, 1989; Dawers and Seeber, 1991; Seeber et al., 1998). Multiple prehistoric surface ruptures closely spaced in time were discovered on some of the intraplate faults (e.g., the Meers fault in Oklahoma; Crone and Wheeler, 2000). They seem to be clusters of events, which are nevertheless preceded by long periods of quiescence. Long quiescence, therefore, seems to characterize intraplate faults known to have produced damaging or potentially damaging earthquakes.

The rate at which individual "active" intraplate faults produce earthquakes is low even in comparison to the overall rate of earthquake activity in these areas. This has lead to the hypothesis that intraplate deformation and earthquakes are distributed among many faults, including minor ones (e.g., Seeber et al., 1986). The contribution from each fault is small, but together they account for the earthquake activity and hazard in intraplate areas. In order to produce very large earthquakes (M≥7), some of these faults are large, possibly having played a major role in a previous more active geologic regime. Even these large faults however, do not seem to have accumulated much strain in the current intraplate regime. The 1811-12 New Madrid sequence in the central US and the 1819 and 2001 earthquakes near Bhuj, western India, are among the larges known intraplate earthquakes. Both sequences include reverse faulting that thickens the crust and thus tends to increase topography. Yet these earthquakes have occurred in parts of the continents barely above sea level and with no evidence of sustained uplift.

Along plate boundaries, few master faults deliver much of the strain release and hazard. This concentration of strain is consistent with strain-softening, which seems to control many geological phenomena, including the reactivation of pre-existing faults widely noticed for intraplate earthquakes (e.g., Sykes 1978). The partitioning of strain over many faults is counter to strain-softening behavior and may be symptomatic of widespread application of the forces that drive intraplate deformation. In any case, the important conclusion for hazard is a negative one: geologic evidence of no rupture in recent geologic time (e.g., ≥0.1 million years) and/or very slow slip rates are not useful criteria to characterize the earthquake potential of an intraplate fault. The concept of 'capable fault' was developed in active areas. Given current understanding about intraplate earthquake and deformation regimes, geologic information needs to be applied differently in the evaluation of earthquake hazard in those areas. Rather than time since last rupture or slip rate, more useful criteria would be fault geometry, size, and orientation relative to current stress regime. Some of the faults shown to generate earthquakes in the NYCSZ are secondary, but appear to share a common geometry – a NW strike – and to be genetically related. Another important role of geology is therefore to identify families of faults that are likely to behave similarly in the current intraplate regime.

Given that intraplate earthquakes are distributed on many faults, should all faults be considered potential sources of earthquakes? No. Evidence often points to specific faults or families of faults and the NYCSZ offers a case in point. The NYCSZ is centered along the Appalachian thrust-fold belt. This 'compressional' belt developed during a long-standing convergence boundary and repeated plate collisions during the Paleozoic era. During the Mesozoic, the era of dinosaurs, this belt of shortening and mountain building became a rift zone of extension and developed a series of basins by reversing motion on some of the faults active during horizontal shortening. The Ramapo fault offers a prominent example of this behavior (e.g., Ratcliffe et al., 1986). From this long tectonic evolution, the eastern seaboard of North America inherited a set of major NE striking faults that control the exposed lithology and thus the current morphology of the Appalachian Mountains. The inherited structures include also secondary faults, which are generally smaller in both lateral dimensions and accumulated displacement. Prominent among the secondary faults in the NYCSZ, is a set striking NW, approximately perpendicular to the northeasterly strike of the Appalachians (Figure 2; Hall, 1991; Dawers and Seeber, 1991).

The Ramapo Fault

The fault system that borders the Newark Basin, including the Ramapo fault, is one of the most prominent structural and geomorphic features within the NYCSZ. This fault system played a critical role in both the compressional phase that formed the Appalachians and in the rifting that followed (e.g., Ratcliffe et al., 1986). It is now associated with the most prominent feature in the spatial distribution of earthquakes of the NYCSZ. On a map view, epicenters are concentrated along the Hudson Highlands and increase in density to the SE reaching a maximum below the trace of the Ramapo fault (Figure 2). In the Newark Basin southeast of the fault earthquake activity is low. Thus the trace of the Ramapo fault marks both a maximum and a boundary in the earthquake activity. This strong spatial association became clear decades ago and was a central issue during early discussions about earthquake hazard at Indian Point, which is very close to the fault. Improved and more abundant earthquake data have since raised two issues. First, these data illuminate the ruptures of several earthquakes in the NYCSZ, some very close to the Ramapo fault. None of these ruptures were on that fault, however, nor were they on similar first-order faults parallel to the Appalachians (e.g., Seeber et al., 1998). Second, the Ramapo fault dips to the SE below the Newark Basin, but the earthquake activity is clustered in a sub-vertical zone below the surface trace of the fault rather than along the subsurface part of the fault (e.g., report by Lynn Sykes). These two observations detract from a simple and straightforward interpretation of the current role of the Ramapo fault and its potential to generate damaging earthquakes. Nevertheless, the obvious spatial correlation between this fault and earthquake activity gives it a central role for earthquake hazard, even if only on statistical grounds. Furthermore, a spatial correlation coupled with lack of earthquakes on the fault itself characterize portions of the San Andreas fault and other master faults during interseismic periods between major ruptures and their aftershocks. The current analogous situation along the Ramapo fault, therefore, does not exclude future earthquakes on this fault.

NW-Striking Fault Set

Most of the secondary NW-striking faults in the NYCSZ have subtle structural and geomorphic surface expressions. Nevertheless, a number of them have been traced over many kilometers and have been named and mapped (Hall, 1991, Dawers and Seeber, 1991; Seeber and Dawers, 1989; Mergurien, 1986; Baskerville, 1982). The 125th street fault across northern Manhattan is one of the better developed and better known of these faults. Geologic data from surface outcrops and in tunnels indicate a mixture of normal and strike slip faulting thought to pertain to a phase of rifting during the Mesozoic. Pre-existence of at least some of these faults during Paleozoic contraction is probable. Despite the relatively minor role of these faults in accommodating strain in the previous tectonic regime, they seem to play a major role in the current intraplate regime. Seismological field investigations of a number of recent earthquakes and aftershocks in the NYCSZ have revealed reliable details about the geometry, size and slip orientation of their fault ruptures. In all cases these ruptures strike NW (Pomeroy et al., 1976; Seberowski t al., 1982; Armbruster and Seeber, 1987; Seeber and Dawers 1989; Dawers and Seeber, 1991; Hough and Seeber 1991; Seeber et al, 1998). The 1985 Ardsley earthquake clearly ruptured the Dobbs Ferry fault that had been recognized as one of the NW-striking faults before the earthquake (Figure 2; Hall, 1991; preliminary map widely available before 1985). Some of the other earthquakes have been tentatively associated with known NW-striking faults.

In 1977 to 1980, a sequence of earthquakes was centered 5km NNE of Indian Point. This sequence of earthquakes is thought to have ruptured one or more NW striking fault(s). No mapped faults have been directly associated with the sequence, but one of the two possible fault planes determined from the seismicity would outcrop approximately along the northwest-striking segment of the Hudson River in the Hudson Gorge, just north of Indian Point. This portion of the river is thought to be controlled by a NW-striking fault. A portion of this fault is mapped across the Hudson Highlands NW of the gorge (Figure 2; Seberowski et al., 1982). Another NW-striking fault – possibly the same fault – has been mapped on the east bank of the river 5km NNW of Indian Point (Ratcliffe, 1980). This is a small fault, but is thought to be the youngest of the mapped faults in that area. The existence of such a young fault, which may be related to a sequence of earthquakes, needs to be acknowledged and further examined especially given its proximity to Indian Point.

In addition, the overall pattern of earthquake activity in the NYCSZ is characterized by a sharp NW-striking boundary separating the seismic zone from an aseismic area to the NE. This boundary is well expressed across Westchester, reaching the Hudson Gorge slightly north of Indian Point. This feature in the current seismicity traverses the Manhattan Prong, a geologic terrane characterized by intense deformation and temperature effects interpreted to represent the core of the Appalachian belt. The boundary to the earthquake activity has not been associated with a particular geologic structure or lithologic boundary, except that it is sub-parallel to the NW-striking fault set and may coincide with one or more faults in this set yet to be mapped (Hall 1991). This correlation is comparable with the Ramapo fault serving as the SE boundary of the earthquake activity in the Hudson Highlands. In both cases the significance of the spatial correlation between earthquake activity and these geologic structures is unclear, but it indicates a role of these structures in the current regime and, in the case of the NW-striking fault set, it reinforces the suggestion from studies of individual earthquakes that faults in this set should be considered possible sources of significant earthquakes.

Depth range of intraplate earthquakes

Along the San Andreas transform in California and in many other tectonically active regions, most hypocenters are deeper than 5 km and large earthquakes tend to nucleate near the brittle-ductile transition at mid-crustal depths (10-15km). These large earthquakes may rupture to the surface, yet most of the seismic energy is released in the deeper part of the rupture where high confining pressure keeps the rock strong. Most intraplate areas exhibit a binomial depth-distribution of earthquake activity, markedly different from the distribution in active regions (Figure 1). Many intraplate earthquakes, including large ones, are very shallow. Most of the recent and well-studied $M \geq 6$ intraplate earthquake ruptures are confined within the upper ~5 km of the crust and reach the surface, although the recent very large intraplate earthquake in Bhuj (west India) 2001 ruptured the deep crust and did not reach the surface. Small intraplate earthquakes are also mostly shallow, but difficulty of distinguishing depths in the upper 10 km when stations are sparse leads to a tendency to overestimating depth in routine analyses. Some intraplate earthquakes originate in the mid to deep crust, deeper than 15-20km, a depth range where deformation occurs a-seismically along the San Andreas Fault in California.

The deeper intraplate earthquakes seem to occur primarily along ancient rift zones, no more active as such, but still characterized by large deep-rooted faults. Passive continental margins are in this category. These areas have also been associated with the largest of the intraplate earthquakes, such as the 1811-12 series in New Madrid MO, the 1886 Charleston event, and the one in Bhuj in 2001. The NYCSZ is situated along a passive continental margin and includes prominent rift structures such as the Newark Basin and the Ramapo fault (Figure 2). In this seismic zone, some of the earthquakes occur at mid-crustal depths, but many reliable hypocenters show that very shallow earthquakes predominate. Among these, the Mw4.7 1994 earthquake near Reading is the largest, and ruptured a fault in the upper 2.5 km (Seeber et al., 1998). This earthquake was triggered by a very small stress change caused by a quarry. Nevertheless, this depth is characteristic of natural earthquakes along the Reading Prong. Two M4 earthquakes on the southeast side of the prong, in Lancaster PA 1984 (Armbruster and Seeber, 1987) and Ardsley NY 1985 (Hough and Seeber, 1991), were 4-to-5 km deep. The Ansville sequence of earthquakes, 1977-1980, is centered only 5 km NNE of Indian Point and is centered at a depth of about 2 km (Seberowski et al., 1982).

The shallow depth of many intraplate earthquakes is now gradually being recognized. A few decades ago only small earthquakes insignificant for hazard ("microearthquakes") were thought to originate in the very shallow part of the crust (depth <5km). The same earthquakes raised from a typical California depth range to one appropriate for an intraplate area such as the Reading Prong, would be closer to people and structures and probably cause higher intensity, even without accounting for differences in seismic attenuation. The most obvious effect is to lower the magnitude threshold for which damage can start. This can dramatically increase the number of damaging earthquakes because the number of earthquakes in a given magnitude range increases logarithmically with decreasing magnitude. Thus, if the threshold were to decrease from M5 to M4, the number of damaging earthquakes may increase nearly 10 times. At close distances, these small shallow earthquakes can be expected to produce a burst of shaking of short duration shifted toward frequencies higher than would be expected from larger and deeper events also at the damage threshold. The kind of damage would differ; acceleration would be higher from the shallow events and velocity would be higher from the deeper events. Stress-drop, which affects the source spectrum, and the depth distribution of seismic attenuation, which affects the intensity fall off with distance, are also likely to play a major role in determining the hazard from shallow intraplate earthquakes. We have recognized that an important component of intraplate earthquake activity is very shallow (Close an Seeber, 2007; Figure 1), but have so far done little to explore how it may differ in other ways from deeper intraplate earthquake activity and how these differences may affect the hazard.

Anthropogenic Earthquakes

Finally, the potential of large intraplate earthquakes to nucleate at shallow depths increases the potential for engineering activities to trigger damaging earthquakes. Stress and pore pressure changes induced by a variety of operations, such as mining, quarrying, and fluid waste disposal, can be significant in the very shallow crust, but rarely at depth where large California earthquakes tend to nucleate. Thus anthropogenic earthquake activity has been a minor concern along the San Andreas plate boundary and in other tectonically active regions. Nevertheless, a portion of intraplate earthquake activity in populated areas, including the NYCSZ, seems to be anthropogenic or suspected of being so. This earthquake activity is added onto the natural earthquake activity and is expected to be particularly shallow and close to people and thus more likely to be damaging (e.g., McGarr et a., 2002). It is also expected to increase as engineering operations increase in number and size. The largest instrumentally recorded earthquake in the NYCSZ, the 1994 M4.7 earthquake near Reading PA, was triggered by a quarry (Seeber et al., 1998). Available data worldwide show no evidence that the magnitude range of anthropogenic and of natural shallow intraplate earthquakes differ (e.g., Table 1). Liability issues are often of great concern and tend to interfere with the study of anthropogenic earthquake activity and its implications for hazard.

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Glossary of Key Terms

Anthropogenic: A byproduct of human activities. In the case of earthquakes, it refers to mechanical perturbations of the Earth's crust that could trigger fault rupture. In order to be significant, anthropogenic perturbations have to be larger than stress excursions associated with tides. Observations in tectonically active areas with intense earthquake activity show that static Coulomb stress perturbation (i.e., permanent changes in the elastic field) caused by large earthquakes start or enhance earthquake activity on some faults and decrease or shut down earthquake activity on others. These changes have been observed for calculated stress changes as small as 0.01MPa. A water-level change of only 1 meter generates a similar stress changes. Many types of engineering activities could thus generate significant stress perturbations. The following are often reported to trigger earthquakes: reservoir impounding; injection of fluids in deep wells; extensive mining of fluids, typically oil or water; deep underground cavities in mines; removal of surface load in quarries.

b-value: Slope of the line in log-linear plots describing the distribution of earthquakes over the magnitude range: $\log N = a - bm$. N is the cumulative number of earthquakes, i.e., with magnitudes $\geq m$, and a and b are constants, referred to as the "a-value" and "b-value". These constants are critical for hazard evaluations. The a-value measures the level of earthquake activity; the b-value establishes the expected rate of large damaging earthquakes in terms of the observed rate of much more numerous small earthquakes. Typically, there are about 10 earthquakes of magnitude m for each earthquake magnitude m+1, i.e., $b \approx 1$.

Coulomb Stress: A scalar assessment of the stress condition on a particular fault according to the Coulomb criterion for failure $\tau \geq \mu(\sigma_n - p)$. The shear and normal stress on the fault are τ and σ_n, respectively, p is the pore-fluid pressure, and μ is the coefficient of friction. The fault does not fail as long as the

Coulomb stress $\tau-\mu(\sigma_n-p)\leq 0$. A fault can be brought closer to failure by an increase in shear stress, or by a decrease in normal stress, or by an increase in pore pressure. Earthquakes may be triggered by perturbations of any of these parameters.

Craton: Geologically stable continental regions (SCR) that have not experienced extensional deformation since the last major pervasive compressional deformation event. This compression is typically associated with continental collision and growth by accretion. The compressional deformation is old, typically Precambrian, so that erosion has denuded the continent to near sea level and has exhumed rocks originally at mid-to-deep crustal levels. Historic data worldwide suggest that maximum earthquake size in cratons is in the magnitude 6-7 range. Instrumental data indicates that earthquake activity in cratons is concentrated in the upper few km of the crust.

Induced: An earthquake that results from a change of the Coulomb stress that is a substantial portion of the level of stress at failure. The upper SCR crust is generally close to failure, thus most significant earthquakes derived from anthropogenic perturbations are probably triggered. Small earthquakes may be induced locally near the sources of the perturbations, where the stress change may be large.

Intraplate: Within a plate, i.e., not a plate boundary. Intraplate areas include SCRs, as well as stable zones of oceanic crust as well as continental zones with significant diffused deformation, such as central Asia or western North America east of the San Andreas plate boundary.

Paleorift: Tectonically stable continental regions (SCR) that have experienced extensional deformation. Rifting precedes the current SCR regime, but postdates the last major pervasive compressional deformation event. Paleorifts are known or inferred to harbor large faults that accommodated the extension and rifting. The brittle upper crustal portion of the faults are typically preserved because little or no denudation has effected the continent after the rifting. All known SCR earthquakes in the magnitude ≥7 range are in these regions. Most of the sources of deep crustal earthquake activity are also in these regions.

Stable continental regions (SCR) An intraplate continental area that exhibits little or no evidence of accumulated geologic deformation. SCRs incude cratons and paleorifts.

Stress Drop: The release in stress associated with slip on a fault. An earthquake transforms elastic strain energy into seismic energy, fracture energy, and heat. As a result, the stress generally decreases on the fault rupture and on parts of the surrounding rock. Stress drop refers to the average change of stress on the fault rupture.

Triggered: An earthquake that results from a perturbation of the Coulomb stress which is small to the pre-existing level of stress or to the drop in stress caused by the fault rupture associated with the earthquake. Earthquakes can be triggered by natural causes, such as other earthquakes, or by anthropogenic perturbations. Earthquakes can only be triggered on faults that are already close to failure. Stress changes as small as 0.01MPa (0.1 bars) are known to trigger earthquakes. The upper SCR crust appears to be generally close to failure, thus most significant earthquakes derived from anthropogenic perturbations are probably triggered.

TABLE 1

Mb≥6.0 or Ms≥6.0 or Surface Rupture in Stable Continental Regions; PDE; 1960-1990

N	DATE	LAT.	LON.	Mb	Ms	RAKE degr.	DEPTH km			
Australia										
1.	1968 10 14	-31.518	116.971	6.0	6.8	62	(0-6)	CRA	SR	NT
2.	1970 03 10	-31.01	116.54	5.7		90?	(0-?)	CRA	SR	ET?
3.	1970 03 24	-21.981	126.682	6.2	5.9	80±5	8±3	CRA		NT
4.	1975 10 03	-22.126	126.721	6.0			C	CRA		ET?
5.	1979 06 02	-30.812	117.179	6.0	6.1	98±10	3±1	CRA	SR	ET?
6.	1986 03 30	-26.194	132.767	5.8	5.8	80±25	(0-3)	CRA	SR	?
7a.	1988 01 22	-19.798	133.910	6.1	6.3	90±10	6.5 4.5 2.0	CRA	SR	?
7b.	1988 01 22	-19.847	133.803	6.1	6.4	120±10	3.5 3.0 3.0	CRA	SR	ET
7c.	1988 01 22	-19.829	133.882	6.5	6.7	80±10	4.5 4.5 4.0	CRA	SR	ET
India										
8.	1967 12 10	+17.700	073.900	6.0		0±35	4.5	CRA	SR	T
9.	1993 09 29	+18.066	076.450	6.3	6.2	100	2.6 (0-6)	CRA	SR	T?
N America										
10.	1988 11 25	+48.050	288.900	5.9	6.0	60	(25-30)PR		NT	
11.	1989 12 25	+60.080	286.555	6.2	6.3	90	(0-3)	CRA	SR	NT
Africa										
12.	1982 12 22							PR?	SR	NT

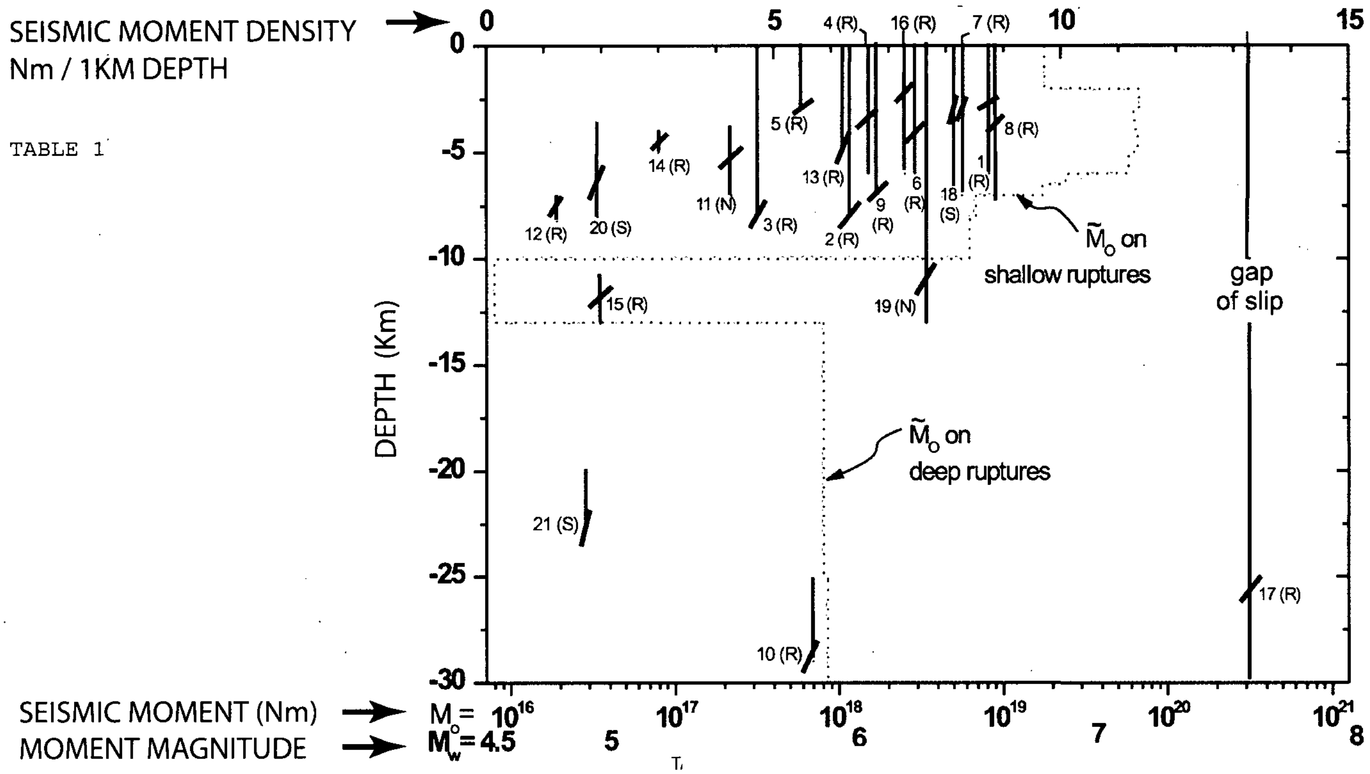
1.	1968 Meckering	Gordon and Lewis, 1980; Vogfjord and Lagston, 1987
2.	1970 Calingiri	Gordon and Lewis, 1980
3.	1970 Canning Basin	Fredrich et al., 1988
4.	1975 Canning Basin?	PDE
5.	1979 Cadoux	Lewis et al., 1981; Fredrich et al., 1988
6.	1986 Marryatt Creek	Machette et al., 1993; Fredrich et al., 1988
7.	1988 Tennant Creek	Choy and Bowman, 1990; Crone et al., 1992
8.	1967 Koyna	Sahasrabudhe et al., 1969; Langston, 1981
9.	1993 Killari	Seeber et al., 1996; Baumbach et al., 1994
10.	1988 Saguenay	North et al., 1989
11.	1989 Ungava	Adams et al., 1991
12	1982 Guinea	Langer et al., 1987

CRA:	craton
PR:	paleorift zone
DEPTH:	centroid and (depth range) for rupture or subevents
C:	crustal depth poorly resolved
SR:	surface rupture

ET:	triggered by a previous earthquake
T:	anthropogenic triggering
NT:	no known possible cause of anthropogenic triggering
T?	possibility of triggering is being debated
?	triggering is not being investigated, but possible trigger is near epicenter.

Note: Events 1, 2, 5 and events 3, 4 form spatial clusters similar to events 7a,b,c. They may be dependent sequences.

TABLE 1

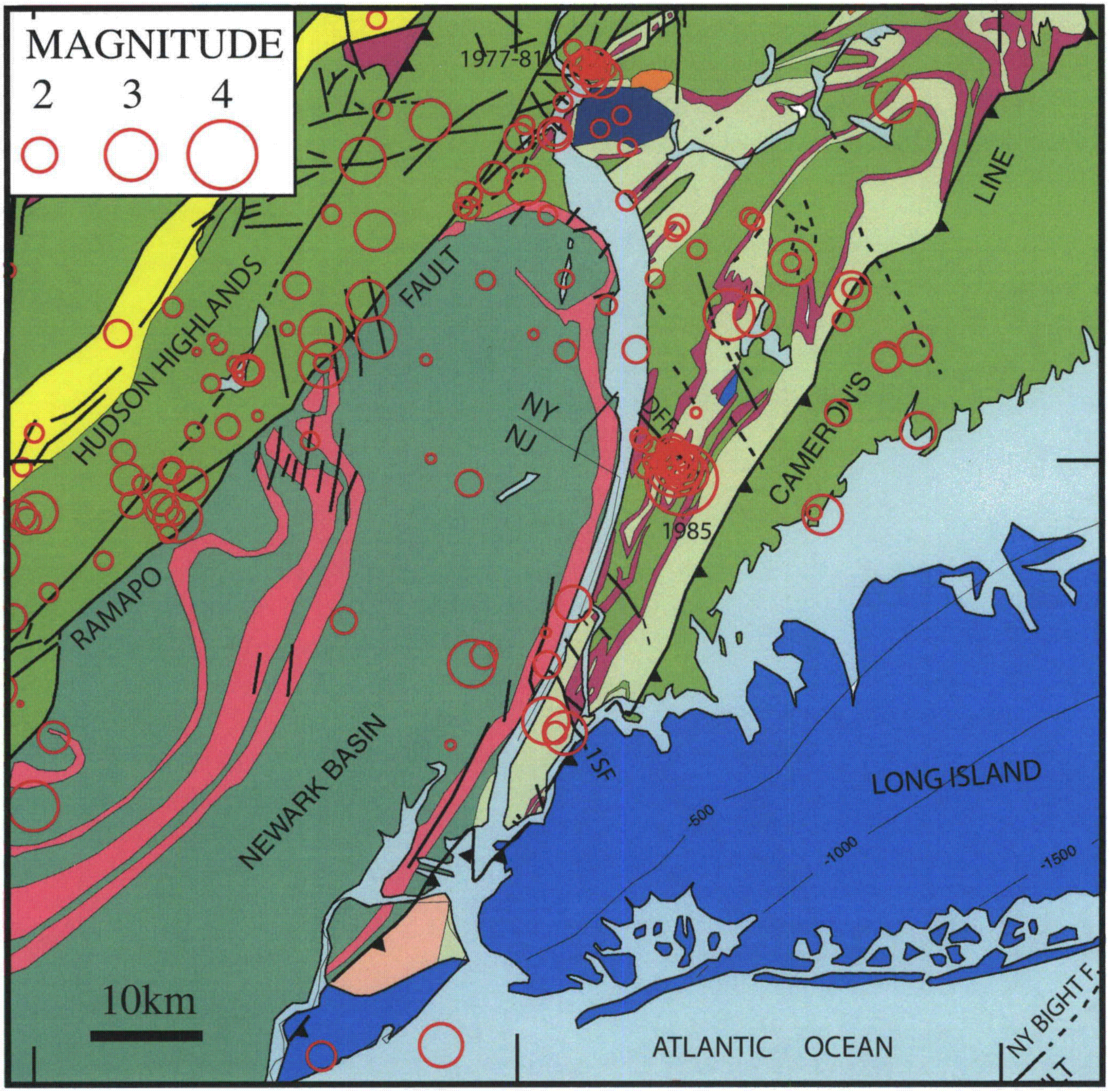


zone types R=reverse, S

No.	SCR-earthquakes	Date dd/mm/yyyy	Rupture extension [km]	Focal depth [km]	Relative depth [%]	Crustal thickness [km]	Fault type	Seismic moment M_o [Nm]	Dip angle [°]	References
Australia										
1	Meckering, AU	14/10/1968	0–6	3.0	19	32.5	R	8.20×10^{18}	29	Vogfjord and Langston (1987), Fredrichet al. (1988)
2	Lake McKay, AU	24/03/1970	0–8	8.0	25	32.5	R	1.17×10^{18}	45	Fredrichet al. (1988)
3	Simpson Desert, AU	28/08/1972	0–8	8.0	25	32.5	R	3.16×10^{17}	60	Fredrichet al. (1988)
4	Cadoux, AU	02/06/1979	0–6	4.0	19	32.5	R	1.49×10^{18}	34	Fredrichet al. (1988)
5	Marryat Creek, AU	30/03/1986	0–3	3.0	7	43.0	R	5.80×10^{17}	35	Fredrichet al. (1988)
6	Tennant 1, AU	22/01/1988	0–6	4.5	14	43.0	R	2.90×10^{18}	35	Choy and Bowman (1990)
7	Tennant 2, AU	22/01/1988	0–7	3.0	16	43.0	R	5.20×10^{18}	70	Choy and Bowman (1990)
8	Tennant 3, AU	22/01/1988	0–7	4.5	16	43.0	R	8.30×10^{18}	45	Choy and Bowman (1990)
North America										
9	Baffin Bay, Canada	04/09/1963	0–7	7.0	19	37.5	R	1.70×10^{18}	41	Hasegawa and Adams (1990)
10	Saguenay, Canada	25/11/1988	25–30	29	77	37.5	R	6.90×10^{17}	67	Northet al. (1989)
11	Miramichi, Canada	09/01/1982	3.5–7		19	37.5	N	2.20×10^{17}	50	Wetmilleret al. (1984)
12	Goodnow, USA	07/10/1983	7–8	7.5	22	37.5	R	1.90×10^{16}	60	Nabelek and Suarez (1989)
13	Ungava, Canada	25/12/1989	0–5	5.0	13	37.5	R	1.10×10^{18}	70	Adamset al. (1991)
14	Pymatuning, USA	25/09/1998	4–5	4.5	13	37.5	R	1.00×10^{17}	65	Seeber (pers. com.)
15	Au Sable Forks, USA	20/04/2002	10–13	11.5	35	37.5	R	3.50×10^{16}	45	Seeber et al. (2002)
Asia										
16	Killari	29/09/1993	0–6	2.6	16	37.5	R	1.70×10^{18}	46	Seeber et al. (1996)
17	Bhuj	26/01/2001	0–10,13–30	26.0	80	37.5	R	3.16×10^{20}	41	Singhet al. (2004), Bodin and Horton (2004)
Africa										
18	Ceres, RSA	29/09/1969	0–6.5	4.0	16	40.0	S	5.01×10^{18}	87	Green and Bloch (1971)
19	West Guinea	22/12/1983	0–13	11.0	32	35.0	N	3.40×10^{18}	60	Langeret al. (1987)
Europe										
20	Schwabian Jura, D	03/09/1978	3–7.5	6.5	27	30.0	S	3.40×10^{16}	85	Haessler et al. (1980), Scherbaumet al. (1983)
21	North Wales, UK	19/07/1984	20–23	23.0	67	30.0	S	2.24×10^{17}	79	Ansell et al. (1986)

Figure 1. Depth range of ruptures (vertical lines), focal depth, and seismic moment (& moment magnitude), of 21 intraplate continental earthquakes, 4.5<Mw<8. Oblique lines indicate focal depth (rupture initiation) and faut dip. R=reverse, S=strike-slip, N=normal. The line bounding the shaded area shows the crustal depth distributionof the seismic moment density (in %/ per 1km depth). From Klose and Seeber, 2007.

TABLE 2



Cretaceous and younger; Coastal Plain deposits

Triassic-Jurassic sediments and basic intrusives

Devonian sediment (Hamilton Group)

Ordovician intrusives

Ordovician shale and siltstone

Ordovician-Cambrian Manhattan schist with serpentine bodies

Ordovician-Cambrian Limestone /marble

Precambrian gneiss and granite

Faults barbs on hangingwall of thrusts

-500 Bedrock depth contours in feet

Figure 2: Bedrock map of the New York City area and epicenters (1975-2002). The 1985 earthquake occurred on the Dobbs Ferry fault (DFF), which is one of a family of NW-striking faults that include the 125th Street fault in Manhattan (1SF)

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Related Publications:
2004 Seeber, L., J.G. Armbruster, and W.-Y. Kim, A fluid-injection triggered earthquake sequence in Ashtabula OH: Implications for seismogenesis in stable continental regions, Bull. Seism. Soc. Am. 94, 76-87.
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Significant Recent Publications:

2007, Seeber, L., C. Mueller, T. Fujiwara, K. Arai, W. Soh, Y. S. Djajadihardja, M.-H. Cormier, Accretion, mass wasting, and partitioned strain over the 26 December 2004 M9.2 rupture offshore Aceh, northern Sumatra, accepted Earth & Planetary Science Letters.

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Synergistic Activities:

•2001-2005: Steering Committee of the Center for Hazard and Risk Research of the Columbia University Earth Institute; Application to the reduction of earthquake risk in Istanbul, Turkey.

•1996-1999 Co-PI in NSF-funded project targeting High School curricula: Earth-View Explorer: An Interactive Educational Tool to Explore Topics in Earth Science;

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•1992-2002 Member Board of Directors Southern California Earthquake Center;

•1998-1999 Conceptualization and Design of exhibits for the Hall of the Earth in the American Museum of Natural History

•1990-2000 Development of a hypocenter, focal mechanism, and slip plane data base for southern California from phase data of the southern California Network (*Anonymous FTP*: scec.gps.caltech.edu; *Directory:* /pub/focal; *File:* focal1.nano).

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