September 21, 2012

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket Nos. 50-247-LR/ 50-286-LR
	)	
(Indian Point Nuclear Generating Units 2 and 3)	)	

NRC STAFF TESTIMONY OF STEPHEN P. KLEMENTOWICZ AND JAMES D. NOGGLE CONCERNING CONTENTION RIVERKEEPER EC-3/CLEARWATER EC-1 (SPENT FUEL POOL LEAKS)

Q.1. Please state your names, occupations, and by whom you are employed.

1(a). My name is Stephen P. Klementowicz (SPK).[1] I am employed as a Senior Health Physicist in the Division of License Renewal, Office of Nuclear Reactor Regulation ("NRR"), U.S. Nuclear Regulatory Commission ("NRC"), in Washington, D.C. A statement of my professional qualifications is attached hereto, as Exhibit NRC000089.

1(b). My name is James D. Noggle (JDN). Since July 15, 2012, I have been employed as Chief of Plant Support Branch 2, Division of Reactor Safety ("DRS"), U.S. Nuclear Regulatory Commission ("NRC") Region I, in King of Prussia, PA. Previously, I served as a Senior Health Physicist in that Branch. A statement of my professional qualifications is attached hereto as Exhibit NRCR00090.

Q.2. Please describe the nature of your responsibilities on behalf of the NRC Staff ("Staff").

[1] In this testimony, answers provided by specific witnesses are identified by denoting those witnesses' initials at the beginning of the answer. Where an answer is provided by all witnesses, the witnesses' initials are not provided.

2(a). (SPK) I have worked as a health physicist in the Division of License Renewal in the NRC's Office of Nuclear Reactor Regulation for over five years. My current duties involve the preparation of portions of the Staff's environmental impact statements for nuclear power plant license renewal applications, in the areas of occupational and public radiation exposure, electromagnetic exposure, decommissioning, and design basis accidents. During this period, I served as the technical reviewer for 14 license renewal supplemental environmental impact statements ("SEIS") and 12 environmental assessments, and I participated in six onsite environmental audits for license renewal. In each of my license renewal reviews, I performed a technical review in the areas of occupational and public radiation exposure, electromagnetic exposure, decommissioning, and design basis accidents.

Prior to joining the Division of License Renewal, I worked for 16 years in the Health Physics Branch in the Division of Inspection Program Management, in the Office of Nuclear Reactor Regulation. As part of my responsibilities, I served as the lead NRR technical staff reviewer for radiological effluent and other environmental issues involving the NRC's reactor inspection program, and participated in the preparation of safety evaluation reports for license amendment applications from nuclear power reactors. In addition, I served as the technical lead for the development of the "Public Radiation Safety Cornerstone" ("PRS Cornerstone") for the new NRR Reactor Oversight Process inspection program, which went into effect in 2000. For this new inspection program, I was responsible for development of the NRC inspection protocols for radioactive material controls, radiological effluent monitoring programs, and radiological environmental monitoring programs; and I provided programmatic and technical support to NRR and Regional Inspectors on issues related to the PRS Cornerstone.

In addition, I served as a member of the NRC's "Liquid Radioactive Release Lessons Learned Task Force" ("Task Force") that was established to address the issue of inadvertent leaks of radioactive liquids into groundwater from components and buried piping at nuclear power reactor plant sites, leading to issuance of the NRC Task Force report on September 1,

2006 (Exhibit RIV000091). As part of this work, I prepared the Task Force report's section on the NRC's regulatory requirements and regulatory guidance for radiological effluent and environmental monitoring programs. Finally, I was a member of the NRC's Emergency Response Organization for 15 years, in which capacity I performed dose assessment calculations to assess the radiological dose impacts from nuclear power reactor accidents.

2(b). (JDN) Since July 15, 2012, I have served as Chief of Plant Support Branch 2 ("PSB2") in the Division of Reactor Safety, NRC Region I, where I am responsible for reactor health physics and incident response in NRC Region I. From August 1990 to July 2012, I served as a health physicist and senior health physicist in PSB2, NRC Region I, with responsibility for radiation safety inspections at various nuclear power plants in Region I, including Pilgrim, Susquehanna, Vermont Yankee, Calvert Cliffs, Beaver Valley, Millstone, Seabrook, Salem, Hope Creek, Peach Bottom, Limerick, Three Mile Island, Fitzpatrick, Nine Mile Point, Ginna, and Indian Point Units 1, 2 and 3. As part of my responsibilities, I participated in or led the NRC's effluent and environmental protection inspection activities at Indian Point Units 2 and 3. In addition, I led the NRC Staff's groundwater investigation team inspections at the Indian Point site, from September 2005 through December 2011. I am certified in Comprehensive Health Physics by the American Board of Health Physics.

In addition to leading the NRC Staff's Indian Point groundwater contamination special team inspections, I participated in several industry groundwater workshops to develop the industry's voluntary groundwater protection initiative (NEI 07-07) and the implementing guidance subsequently provided by the Electric Power Research Institute ("EPRI"). During the period of January 2010 through January 2012, I served as the NRC Staff's inspection team leader for a contaminated groundwater leak investigation at the Vermont Yankee nuclear power plant. This was also a special NRC inspection team effort that included NRC hydrogeology experts, a hydrogeology supervisor from the U.S. Geological Survey ("USGS"), and State hydrogeologists from Vermont, New Hampshire and Massachusetts. In addition, I represented the NRC in a

groundwater panel discussion during the March 2011 NRC Regulatory Information Conference and in a panel discussion during the November 2011 meeting of the American Nuclear Society ("ANS") to roll out the new ANS/American Nuclear Standards Institute ("ANSI") standard, ANSI/ANS-2.17-2010, "Evaluation of Subsurface Radionuclide Transport at Commercial Nuclear Power Plants," issued in December 2010.

Q.3. Please explain what your duties have been in connection with the NRC Staff's review of the license renewal application (LRA) submitted by Entergy Nuclear Operations, Inc. ("Entergy" or "Applicant") for Indian Point Nuclear Generating Units 2 and 3 ("IP2" and "IP3, or "Indian Point"), and/or the Staff's inspection and oversight of the Indian Point site.

A.3(a). (SPK) From May 2007 until December 2010, I served as the principal health physics reviewer for radiological issues associated with the Staff's environmental review of the IP2/IP3 LRA. As part of my responsibilities, I was principally responsible for preparation of certain sections in the Draft Supplemental Environmental Impact Statement, NUREG-1437, Supplement 38 (Dec. 2008) ("DSEIS" or "Draft SEIS") (Exhibit NYS000132A-D), and Final Supplemental Environmental Impact Statement, NUREG-1437, Supplement 38 (Dec. 2010) ("FSEIS" or "Final SEIS"), issued for the IP2/IP3 LRA (Exhibit NYS000133A-J), related to radioactive waste management systems, radioactive effluent control systems, and the potential radiological impacts of license renewal (including impacts related to radioactive gaseous and liquid effluents, and the release of radioactive fluids through leaks in the spent fuel pools ("SFPs") at the Indian Point site).

Specifically, I was the NRC's principal technical reviewer responsible for preparation of the following sections of the Staff's Draft and Final SEIS for the IP2/IP3 LRA:

- Section 2.1.4, Radioactive Waste Management Systems and Effluent Control Systems;
- Section 2.2.7, Radiological Impacts;
- Section 3.2, Refurbishment Impacts (radiological issues only);

- Section 4.2.1, Electromagnetic Fields – Acute Effects;
- Section 4.2.2, Electromagnetic Fields – Chronic Effects;
- Section 4.3, Radiological Impacts of Normal Operations;
- Section 4.7, Evaluation of New and Potentially Significant Information on Impacts of Operations during the Renewal Term (radiological issues only);
- Section 4.8.3, Cumulative Radiological Impacts;
- Section 5.1.1 Design-Basis Accidents;
- Section 6.1, The Uranium Fuel Cycle;
- Section 7.0 Environmental Impacts of Decommissioning; and
- Appendix A, Comments Received on the Environmental Review (radiological issues only).

A.3(b). (JDN) As indicated in response to Question 2 above, for the past twelve years, I participated in or led the NRC's effluent and environmental protection inspection activities at Indian Point Units 2 and 3, and I led the NRC Staff's groundwater investigation team inspections at the Indian Point site from September 2005 through December 2011. In my role as team leader for the Staff's groundwater inspections at IP1 and IP2 during the past six years, I directed the team's inspections of the Indian Point site and its review of Entergy's investigation of groundwater contamination resulting from leaks in spent fuel pools at the site. In the course of these inspections, the Staff's inspection team worked with hydrogeology experts from the NRC, the USGS, and the New York State Department of Environmental Conservation ("NYSDEC"); and three health physics experts from NRC Region I and NYSDEC. The findings and conclusions of these team inspections are documented in the following Inspection Reports (IR):

- IR No. 05000247/2005011, September 13, 2005 – February 28, 2006 (Exhibit RIV000069);
- IR No. 05000247/2006003; 05000286/2006003, June 12-13, 2006 (Exhibit NRC000091);
- IR No. 05000247/2006005; 05000286/2006005, November 13-17, 2006 (Exhibit

NRC000092);

- IR No. 05000247/2007002; 05000286/2007002, February 26 – March 21, 2007 (Exhibit NRC000093);
- IR No. 05000247/2007003; 05000286/2007003, May 9-10, 2007 (Exhibit ENT000347);
- IR No. 05000247/2007004; 05000286/2007004, July – August 2007 (Exhibit NRC000094);
- IR No. 05000003/2007010; 05000247/2007010, November 7, 2007 – May 7, 2008 (Exhibit RIV000067); and
- IR No. 050000003/2009008; 05000247/2009008; 05000286/2009008, August 18 – September 4, 2009 (Exhibit ENT000343).

Q.4. What is the purpose of your testimony?

A.4. The purpose of our testimony is to present the NRC Staff's views with respect to Contention Riverkeeper EC-3/Clearwater EC-1 ("RK EC-3/CW EC-1"), which the Atomic Safety and Licensing Board ("Board") admitted in LBP-08-13 on July 31, 2008.

Q. 5. Please identify the documents and other materials you reviewed in preparing to testify in this proceeding**.**

A.5(a). (SPK) In preparing to testify in this proceeding, I reviewed (a) applicable NRC regulations in 10 C.F.R. Parts 20, 50, and 51; (b) applicable NRC regulatory guidance documents, the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437 (May 1996) ("GEIS") (Exhibit NYS000131), and Addendum 1 thereto; (c) regulations issued by the U.S. Environmental Protection Agency in 40 C.F.R. Part 190; (d) applicable portions of Entergy's Indian Point-related submittals, including the LRA, the ER, supplements to the LRA, responses to Staff Requests for Additional Information ("RAIs"), and the Updated Final Safety Analysis Report for IP2 and IP3; (e) Entergy's reports to the NRC regarding radioactive releases and effluents at the Indian Point site, including its annual radiological environmental operating reports, annual radioactive effluent release reports, the Offsite Dose Calculation Manual for IP2, Entergy's letter of May 15, 2008 ("Remediation and Long Term

Monitoring of Site Groundwater") (Exhibit NRC000095); (f) NRC inspection reports concerning radioactive effluent releases and groundwater contamination at the Indian Point site; (g) certain documents issued by the State of New York (annual reports on environmental radiation, and "Community Fact Sheets"); (h) the Final Environmental Statement for Indian Point Units 2 and 3 (NUREG-75/002 (1975)); (i) the Draft SEIS and Final SEIS for IP2 and IP3; (j) the Board's Memorandum and Order in LBP-08-13; (k) the parties' pleadings regarding the admissibility of this contention; (l) the testimony and exhibits submitted by Riverkeeper in December 2011; and (m) other documents referenced in my testimony below.

A. 5(b). (JDN) In preparing to testify in this proceeding, I reviewed (a) applicable NRC regulations in 10 C.F.R. Parts 20, 50, and 100; (b) applicable NRC regulatory guidance documents; (c) regulations issued by the U.S. Environmental Protection Agency in 40 C.F.R. Part 190; (d) documents pertaining to the geology and hydrogeology of the Indian Point site; (e) documents pertaining to the licensee's detection, investigation, monitoring, reporting, structural evaluation, and corrective actions of leaks involving the spent fuel pools and other structures, systems and components ("SSCs") at the Indian Point site; (f) NRC inspection reports pertaining to radioactive effluent releases, and groundwater contamination at the Indian Point site; (g) documents pertaining to background radiation, and environmental sampling of radioactivity in the Hudson River and its biota; (h) Entergy's annual reports to the NRC regarding radioactive effluent releases at the Indian Point site, including its Annual Radiological Environmental Operating Reports and Annual Radioactive Effluent Release Reports, and (i) the NRC's and State of New York's independent groundwater monitoring well split sample results; (j) applicable sections of the Final SEIS for IP2 and IP3; (k) documents pertaining to decommissioning and site remediation for Indian Point Unit 1; l) the Board's Memorandum and Order in LBP-08-13; (m) the parties' pleadings regarding the admissibility of this contention; (n) the testimony and exhibits submitted by Riverkeeper in December 2011; and (o) other documents referenced in my testimony below.

Q.6. Are you familiar with Contention RK EC-3/CW EC-1?

A.6. Yes. Riverkeeper Contention RK EC-3, as filed on November 30, 2007, by Riverkeeper, Inc. ("Riverkeeper"), generally asserted that Entergy's LRA failed to satisfy the requirements of the National Environmental Policy Act ("NEPA") and NRC regulations in 10 C.F.R. Part 51, because the Environmental Report ("ER") submitted as part of its LRA "does not adequately assess new and significant information regarding the environmental impacts of the radioactive water leaks from the [IP1] and [IP2] spent fuel pools on the groundwater and the Hudson River ecosystem." Similarly, Clearwater Contention EC-1, as filed by Hudson Sloop Clearwater, Inc. ("Clearwater") on December 10, 2007, asserted that Entergy's LRA does not comply with NEPA and NRC regulations in 10 C.F.R. §§ 51.53(c)(3)(iv) and 51.45, in that it "fails to adequately assess 'new and significant' information concerning environmental impacts of radioactive substances that are leaking from spent fuel pools and contaminating the ground water, the Hudson River and the local ecosystem"; lacks sufficient information to aid the Commission in developing an independent analysis; does not, to the fullest extent practicable, quantify the various factors considered; and fails to sufficiently include information concerning the leaks.

We understand that the Board admitted these contentions in its "Memorandum and Order (Ruling on Petitions to Intervene and Requests for Hearing)" ("Order"), LBP-08-13, 68 NRC 43 (July 31, 2008). In its decision, the Board found that Riverkeeper had raised admissible issues regarding the significance of new information (including the data and conclusions in Entergy's hydrogeology report relating to radiological leaks from the spent fuel pools), and whether Entergy's ER contains sufficient information regarding the radioactive impacts of the leaks to aid the Commission in preparing its EIS for license renewal. Similarly, the Board found that Clearwater had raised a genuine dispute regarding the significance of the environmental impacts of the spent fuel pool leaks and whether the maximum groundwater impact (and, in turn, the

maximum dose) has been determined for the site. LBP-08-13, 68 NRC at 290-91 & 296-97. The Board then consolidated these contentions, to state:

> The ER does not adequately assess new and significant information regarding the environmental impacts of radionuclide leaks from spent fuel pool leaks at Indian Point.

Id., at 349. We further understand that, in decisions issued on May 28, 2009 and July 6, 2011, the Board granted Riverkeeper and Clearwater's requests to amend this contention to apply, as well, to the adequacy of the Staff's assessment of the spent fuel pool leaks in its Draft and Final SEISs.

Q.7. Do you agree with the assertion in Contention Riverkeeper EC-3/Clearwater EC-1 that Entergy (in its Environmental Report) and the Staff (in its Final Supplemental Environmental Impact Statement) have failed "to adequately assess new and significant information regarding the environmental impacts of radionuclide leaks from spent fuel pools at Indian Point on groundwater and the Hudson River ecosystem"?

A.7. No. The Applicant's Environmental Report, filed in April 2007, was prepared prior to the collection and assessment of the additional information that later became available. As discussed below, the Applicant has engaged in an extensive groundwater monitoring and characterization effort, subject to NRC and New York State inspection, which produced substantial new information regarding groundwater contamination at the Indian Point site; this information is discussed in the testimony of James Noggle, *infra*. The Staff's FSEIS, issued in December 2010, provides a comprehensive assessment of the information that has become available regarding the spent fuel pool leaks at Indian Point and the environmental impacts of those leaks; the testimony of Stephen Klementowicz, *infra*, describes the Staff's findings and conclusions regarding this matter in the FSEIS for license renewal of Indian Point Units 2 and 3.

REGULATORY REQUIREMENTS

Q.8. Please describe the Commission's requirements governing the release of

radioactive materials and radiation doses resulting from the release of radioactive materials or radioactive contamination at U.S. nuclear power plants, that the NRC Staff utilizes in evaluating the adequacy of a licensee's control, monitoring, and reporting of radioactive effluent releases.

A.8. (SPK) The Commission has adopted a comprehensive set of regulations establishing radiation dose limits, radioactive effluent release standards, radiological environmental monitoring programs, and the reporting of radioactive releases, intended to assure that the use of licensed nuclear materials does not adversely impact workers, members of the public, and the environment. Under 10 C.F.R. § 50.34a, applicants to construct a nuclear power plant are required to submit a description of their equipment and procedures for the control of radioactive effluents and for the maintenance and use of equipment installed in radioactive waste systems. In addition, the operating licenses for nuclear power plants are subject to numerous additional requirements, established in 10 C.F.R. Parts 20 and 50, concerning radiation dose limits, radioactive effluent release limits, surveys and environmental monitoring programs, and the reporting of radioactive releases to the NRC.

Q.9. Please describe the Commission's radiation dose limits, referred to in your response to Question 8 above.

A.9. (SPK) The Commission's regulations establish maximum dose exposure standards (i.e., dose limits) for protecting the public and occupational workers from ionizing radiation resulting from NRC-licensed activities, as set forth in 10 C.F.R. Part 20 ("Standards for Protection Against Radiation"). As stated in 10 C.F.R. § 20.1001(b), these regulations are intended "to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards" prescribed in 10 C.F.R. Part 20.

More specifically, 10 C.F.R. § 20.1301(a)(1) establishes an annual dose limit for individual members of the public of a total effective dose equivalent ("TEDE") of 0.1 rem (100

mrem) (1.0 mSv) per year from any licensed activity (which includes all radioactive gaseous and liquid effluents and any direct radiation from the plant or on-site storage facilities and tanks containing radioactive fluids), exclusive of the dose contribution from background radiation and other specified sources;[2] other dose limits are established for occupational workers in 10 C.F.R. § 20.1201. In addition, 10 C.F.R. § 20.1301(e) requires nuclear power reactors to comply with the Environmental Protection Agency's ("EPA") radiation protection standard in 40 C.F.R. Part 190, which limits the annual dose to a member of the public to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem).[3] Finally, under 10 C.F.R. § 20.1101(b), licensees are required, to the extent practical, to achieve occupational doses and doses to members of the public that are "as low as is reasonably achievable (ALARA)"; this concept, known as the ALARA principle, requires licensees to make "every reasonable effort to maintain exposures to radiation as far below the dose limits in [Part 20] as is practical consistent with the purpose for which the licensed activity is undertaken."

In calculating doses to members of the public from radiation and radioactive effluent releases, the NRC requires consideration of the hypothetical maximum exposed individual. In this regard, consistent with 10 C.F.R. Part 50, Appendix I, and NRC Regulatory Guide 1.109, Rev. 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" (Exhibit ENT000339), the NRC considers the dose to an individual member of the public who is assumed to be maximally

[2] Also, under 10 C.F.R. § 20.1301(a)(2), operations are to be conducted so that "[t]he dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material . . . does not exceed 0.002 rem (0.02 millisievert) [i.e., 2 mrem] in any one hour."

[3] As discussed below, the NRC has also established an ALARA design objective for liquid effluent releases for (a) doses of 1.5 mrem per quarter and 3 mrem per year to the total body, and (b) maximum organ doses of 5 mrem per quarter and 10 mrem per year, as set forth in 10 C.F.R. Part 50, Appendix I ("Numerical Guides for Design Objectives for Operation to Meet the Criterion, 'As Low As is Reasonably Achievable' for Radioactive Material in Light-Water Cooled Nuclear Power Reactor Effluents"). If these ALARA design objectives are not met, the licensee is required to investigate the cause, initiate corrective actions, and provide a 30-day report to the NRC.

exposed, through the environmental pathways by which radioactive releases from the nuclear power plant reach members of the public. For example, liquid radioactive effluent discharges into a river can be incorporated by fish, which in turn can impact people who catch and eat the fish. Discharges into a river can also impact the quality of drinking water, if the river is used as a source of drinking water. Atmospheric discharges of radioactive material, and radiation shine from the reactor and spent fuel stored onsite, also contribute to this dose. To determine compliance with 10 C.F.R. § 20.1301(a)(1), the dose from all of these sources is totaled, to produce a calculated dose for the hypothetical maximum exposed individual. Therefore, as discussed below, the NRC requires that environmental pathways be sampled during the term of the license and evaluated for potential impacts on the environment and members of the public.

Q.10. Please describe the Commission's requirements governing radioactive releases, referred to in your response to Question 8 above.

A.10. (SPK) In addition to complying with the radiation dose limits in 10 C.F.R. Part 20, nuclear power plant licensees are required to comply with 10 C.F.R. § 50.36a ("Technical Specifications on effluents from nuclear power reactors"), and Appendix I to 10 C.F.R. Part 50 ("Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents"). These standards contain criteria for controlling the release of radioactive material, to limit radiation exposures to occupational workers and members of the public, and to limit the impact to the environment.

Specific requirements governing the release of radioactive liquid effluents are provided in 10 C.F.R. § 50.36a, and are detailed in Appendix I of 10 C.F.R. Part 50. These requirements are structured to maintain the dose to members of the public from all radioactive effluent releases to levels that are ALARA; the NRC thus regulates radioactive effluents from nuclear power plants based on the calculated doses resulting to members of the public from the effluents, rather than by setting a limit on the total volume or type of radioactive material discharged.

Licensees are required to establish radiological effluent release technical specifications ("RETS") that contain the ALARA dose criteria from Appendix I, which controls the dose to members of the public. As set forth in Appendix I, Section II, nuclear power plant licensees must provide reasonable assurance that the following ALARA design objective will be met, for liquid effluents: The calculated annual quantity of all radioactive material above background to be released from each reactor to unrestricted areas will not result in an estimated annual dose or dose commitment from liquid effluents for any individual in an unrestricted area (i.e., the hypothetical maximally exposed member of the public) in excess of (a) 3 mrem to the total body per year (0.03 mSv), or (b) 10 mrem (0.10 mSv) to any organ per year. In addition, under Appendix I, Section IV, if the quantity of radioactive material actually released in effluents to unrestricted areas during any calendar quarter results in radiation exposures that would exceed one-half the annual design objective exposure (i.e., 1.5 mrem to the total body and 5 mrem to any organ), the licensee must investigate the cause for that release rate, initiate a corrective action program, and report its actions to the NRC.[4]

Q.11. Please describe the Commission's requirements governing radiation surveys and monitoring, referred to in your response to Question 8 above.

A.11. (SPK) The Commission has established detailed requirements for the performance of radiation surveys and monitoring, and for the implementation of a radiological environmental monitoring program ("REMP"). These requirements may be summarized as follows.

(a) *General Requirements*

In order to demonstrate compliance with the public dose limits in 10 C.F.R. Part 20,

[4] As set forth in 10 C.F.R. Part 50, Appendix I, Section IV.C, if the licensee's monitoring programs result in data showing that the relationship between the quantities of radioactive material released in liquid and gaseous effluents and the dose to individuals in unrestricted areas is significantly different from that assumed in the calculations used to determine design objectives pursuant to 10 C.F.R. Part 50, Appendix I, Sections II and III, the Commission may modify the quantities in the licensee's technical specifications.

licensees are required to perform radiation surveys and monitoring. Thus, 10 C.F.R. § 20.1501 requires that "each licensee shall make or cause to be made, surveys that: (1) may be necessary for the licensee to comply with the regulations; and (2) are reasonable under the circumstances to evaluate: (i) the magnitude and extent of radiation levels; (ii) concentrations or quantities of radioactive material; and (iii) the potential radiological hazards. Surveys are performed based on known historical plant information, as well as for areas that have a potential to be impacted by licensed radioactive material. For on-site spills and leaks which have the potential to contain licensed radioactive material, 10 C.F.R. § 20.1501 requires a licensee to conduct appropriate radiation surveys and monitoring to determine the radiological hazard (*i.e.*, dose assessment) to workers and if there is a viable pathway to the unrestricted area, to members of the public. The surveys and monitoring can continue over a period of time or become an on-going monitoring program in order for the licensee to adequately characterize the extent and source of the contamination from the spills or leak.

Requirements governing radiological effluent and environmental monitoring at nuclear power plants are established in (a) 10 C.F.R. Part 50, Appendix A, General Design Criteria 60, 61, and 64, and (b) 10 C.F.R. Part 50, Appendix I, Section IV.B. In particular, Section IV.B of Appendix I requires as follows:

> B. The licensee shall establish an appropriate surveillance and monitoring program to:
>
> 1. Provide data on quantities of radioactive material released in liquid and gaseous effluents to assure that the provisions of [Section IV.A] section are met;
>
> 2. Provide data on measurable levels of radiation and radioactive materials in the environment to evaluate the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure; and
>
> 3. Identify changes in the use of unrestricted areas (e.g., for agricultural purposes) to permit modifications in monitoring programs for evaluating doses to individuals from principal pathways of exposure.

(b) Radiological Environmental Monitoring Program

Prior to initial licensing, applicants for a nuclear power plant operating license are required to submit a proposed radiological environmental monitoring program, and to conduct a preoperational program that documents the background levels of direct radiation and concentrations of radionuclides that exist in the environment. A licensee's pre-operational environmental monitoring program is reviewed by the NRC Staff in regard to the criteria contained in the NRC's Radiological Assessment Branch Technical Position, Revision 1, "An Acceptable Radiological Environmental Monitoring Program" (November 1979) (Exhibit NRC000096), as partially revised (for pressurized water reactors) in NUREG-1301 ("Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, Generic Letter 89-01, Supplement No. 1" (April 1991) (Exhibit NRC000097).[5] The Branch Technical Position (BTP) contains an example of an acceptable minimum radiological monitoring program for the environment outside a nuclear power plant. The Staff's BTP includes provisions for: (1) monitoring of air at the offsite locations where the highest concentrations of radionuclides are expected; (2) placement of dosimeters in two concentric rings; one ring outside the plant boundary and another ring four to five miles from the site boundary; (3) off site water samples (i.e., surface, ground, and drinking) upstream and downstream of the point of release to the environment; (4) milk samples at locations where the highest doses are expected; (5) and various vegetation and principle radionuclides of concern and the various types of sample material that are to be analyzed.

Once an operating license has been issued, nuclear power plant licensees are required to conduct an operational radiological environmental monitoring program ("REMP"). The requirements of the REMP are specified in the licensee's RETS or Offsite Dose Calculation

[5] For boiling water reactors the REMP is evaluated under BTP Rev. 1, as partially revised in NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors, Generic Letter 89-01, Supplement No.1" (April 1991).

Manual (“ODCM”). In this regard, the licensee must submit: (1) an annual radiological environmental monitoring report (also known as an “Annual Radiological Environmental Operating Report”) which assesses the impact of radiological effluent releases into the environment; and if necessary (2) a Special Report within 30 days of discovery of an event which resulted in a measured radionuclide concentration in an environmental sample exceeding the NRC’s reporting level listed in the BTP or a site-specific value listed in the licensee’s ODCM. The NRC also requires that the licensee participate in an Inter-laboratory Comparison Program to ensure the accuracy and precision of the licensee’s data. Following the first three years of reactor operation, changes to the REMP may be made based upon operational experience. The licensee’s REMP establishes the specific environmental pathways that will be sampled and evaluated during the term of the license.

As discussed above, if the reporting levels in the REMP are exceeded, the licensee must conduct an investigation and prepare and submit a report to the NRC. The problem must also be reported to the NRC in the licensee’s Annual Radiological Environmental Operating Report, discussed in response to Question 12 below. The results of a licensee’s radiological environmental monitoring and effluent controls programs are required to be reported annually to the NRC, and are publicly available. Also, the NRC inspects each licensee's effluent and environmental monitoring programs once every two years, to ensure NRC requirements are met. The status of licensee programs is documented by the NRC in its inspection reports.

The REMP is intended to supplement the results of the licensee’s radiological effluent controls program by verifying that any measurable concentrations of licensed radioactive material and levels of radiation in the environment are not higher than expected on the basis of the effluent measurements and modeling of the exposure pathways. Thus, the REMP criteria in the BTP provide for measurements of radiation and of radioactive material in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from plant operation. Areas in the vicinity of the plant that are assumed to

have a low probability of receiving radioactive effluents from the plant have less or no environmental sampling stations. In this regard, the REMP focuses on the public environment beyond the plant property, and does not require ground water monitoring within the licensee's site for general detection and monitoring purposes. Ground water monitoring within the licensee's site is only required if the ground water is tapped for drinking or irrigation purposes (although special circumstances may exist where a licensee decides to conduct additional groundwater monitoring, or the NRC imposes additional monitoring requirements beyond that which is required by the regulations).[6] In the offsite environment, ground water monitoring is required only of sources that are likely to be affected by the operation of the plant.

Q.12. Please describe the Commission's requirements for reporting releases of radioactive materials, referred to in your response to Question 8 above.

A.12. (SPK) Nuclear power plant licensees are required, pursuant to 10 C.F.R. § 50.75(g), to keep records of information important to the safe and effective decommissioning of the facility. These records include information on known spills or other unusual occurrences involving the spread of contamination in and around the facility or site. These records may be limited to instances when significant contamination remains after any cleanup procedures or when there is reasonable likelihood that contamination may have spread to inaccessible areas; there is no requirement that this information must be submitted to the NRC, however, the records are available for review by NRC inspectors.

In addition, various reporting requirements are established in 10 C.F.R. Parts 20 and 50

[6] Where groundwater contamination has occurred, groundwater monitoring may be necessary to comply with reporting requirements in 10 C.F.R. § 50.75(g)(1) (which requires licensees to keep a record of spills or other unusual occurrences involving the spread of contamination in and around the facility and site for decommissioning purposes) and 10 C.F.R. § 20.1501 (which requires such surveys as may be necessary for a licensee to comply with 10 C.F.R. Part 20, and are reasonable under the circumstances, to evaluate the magnitude and extent of radiation levels, the concentrations or quantities of radioactive material, and the potential radiological hazard posed by radioactive contamination).

pertaining to the release of radioactive materials.[7] First, 10 C.F.R. § 20.2202 provides criteria for notification of incidents. For incidents involving the release of licensed radioactive material, immediate notification of the NRC is required when the event may have caused or threatens to cause a large dose in excess of regulatory limits to an individual (i.e., 25 rem to the whole body, 75 rem to the lens of the eye, or a shallow-dose equivalent skin or extremity dose of 250 rads). For incidents involving doses which are at, near, or slightly above regulatory limits, notification of the NRC is required within 24 hours.

Second, 10 C.F.R. § 20.2203 requires that a written report be sent to the NRC within 30 days after learning of certain occurrences; these radiation doses in excess of the occupational and public limits in 10 C.F.R. Part 20; levels of radiation or concentrations of radioactive material in a restricted area in excess of any applicable limit in the facility's license; or radiation levels or releases in an unrestricted area in excess of 10 times any applicable limit in 10 C.F.R. Part 20 or the facility license. Similarly, under 10 C.F.R. § 20.2203(a)(4), nuclear power plant licensees are required to report to the NRC any occurrences in which radiation levels or releases of radioactive material occur in excess of the Environmental Protection Agency's environmental radiation standards in 40 C.F.R. Part 190.

Third, under 10 C.F.R. § 50.73, nuclear power plant licensees are required to submit a Licensee Event Report (LER) for any of the criteria listed in the regulation, within 60 days after the discovery of the event. As pertinent here, § 50.73(a)(2)(viii)(B) requires a written report for any liquid effluent release that, when averaged over a time period of 1 hour, exceeds 20 times the applicable concentrations specified in Appendix B to 10 C.F.R. Part 20, table 2, column 2, at the point of entry into receiving waters (i.e., unrestricted area) for all radionuclides except tritium

[7] In addition to the reporting requirements discussed above, 10 C.F.R. Part 50 includes reporting requirements, under 10 C.F.R. §§ 50.72 and 50.73, for (a) an emergency event (for which immediate notification is required), or (b) a non-emergency event or situation, related to the health and safety of the public, onsite personnel, or protection of the environment (which may include an inadvertent release of radioactively contaminated materials), for which a news release is planned, or notification to other government agencies has been or will be made (for which a four-hour report is required).

and dissolved noble gases.

Finally, under 10 C.F.R. § 50.36a ("Technical specifications on effluents from nuclear power reactors"), nuclear power plant licenses must include technical specifications that include a requirement that the licensee submit a report to the Commission that specifies the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous 12 months, including any other information as may be required by the Commission to estimate maximum potential annual radiation doses to the public resulting from effluent releases. These reports are known as the licensee's "Annual Radioactive Effluent Release Report." Thus, in addition to any special reports that may be required, nuclear power plant licensees must submit two annual reports each year: (a) an Annual Radioactive Effluent Release Report, and (b) an Annual Radiological Environmental Operating Report.

Q.13. Has the Commission established regulatory limits on radiation doses to organisms other than humans?

A.13. (SPK) No. The Commission's regulations focus on the potential radiological impacts to humans resulting from the use of licensed nuclear materials. To the extent that any organisms other than humans are exposed to radiation or radioactive materials, they are considered only insofar as those organisms may become part of the human food chain and thereby contribute to the dose received by individuals who consume them. Indeed, the Commission has stated that "it is not necessary to develop a framework for radiological protection of non-human species," and the Commission is "oppos[ed] to developing standards for protection of flora and fauna." *See* Staff Requirements Memorandum ("SRM") SRM-04-0223 (January 4, 2005) (Exhibit NRC000098), and SRM-06-0168 (August 23, 2006) (Exhibit NRC000099),. Further, the Commission has stated that it "agrees with the ACRS that there is no evidence that the current set of radiation protection controls is not protective of the environment, and that the NRC should not develop separate radiation protection regulations for plant and animal species." *See* SRM-08-0197 (April 2, 2009) (Exhibit ENT000352). The Commission's

approach in establishing radiation protection standards for humans, and no other species, is consistent with the approach followed by EPA in its regulations (40 C.F.R. Part 190). Consistent with this approach, the Generic Environmental Impact Statement for License Renewal (1996) (Exhibit NYS000131) does not evaluate the potential radiological impacts to non-human biota; likewise, the Environmental Standard Review Plan (NUREG-1555, Supplement 1) (Exhibit NYS00019B) does not provide regulatory guidance for evaluating potential radiological impacts to non-human biota.

Q.14. Has the NRC established a standard for radioactivity in drinking water?

A.14. (SPK) The NRC has not established a standard for radioactivity in drinking water. Such a standard has been established by the Environmental Protection Agency, which requires that radiological releases do not result in radionuclide concentrations in drinking water greater than 20,000 pCi/L. The NRC Staff, in Branch Technical Position, Rev. 1 (Nov. 1979) (Exhibit NRC000096), as revised in NUREG-1301 (Exhibit NRC000097) and NUREG-1302, has provided regulatory guidance on the establishment of an acceptable REMP; this guidance document includes a table listing “Reporting Levels for Radioactivity Concentrations in Environmental Samples,” that includes EPA’s drinking water standard of 20,000 pCi/l. If a licensee’s REMP sample for drinking water exceeds 20,000 pCi/L, the licensee must report it to the NRC and conduct an investigation, in accordance with its Technical Specifications. It should be noted that the EPA’s radiation standards for drinking water apply only to municipal drinking water sources, as set forth in 40 C.F.R. Parts 141.15 and 141.16 (for alpha emitting radioactivity and beta/gamma emitting radioactivity, respectively).

RADIOACTIVE RELEASES AND GROUNDWATER CONTAMINATION AT THE INDIAN POINT SITE

Q.15. Please provide an overview of Entergy's groundwater monitoring program(s).

A.15. (JDN) In accordance with the regulatory requirements described in its Offsite Dose Calculation Manual (ODCM), Entergy has implemented a radiological environmental monitoring program (REMP), which provides for monitoring and reporting the radiological impacts resulting from plant operations. In addition, after Entergy discovered a leak in the Unit 2 spent fuel pool in August 2005 (discussed in response to Question 16 below), Entergy instituted a groundwater monitoring program under 10 C.F.R. § 20.1501, to assess the hazard from the radioactive material; this groundwater monitoring program was later expanded into a site-wide groundwater monitoring program that is documented in the Indian Point ODCM and the licensee's implementing procedures. By letter dated May 15, 2008 (NL-08-079-4) (Exhibit NRC000095), Entergy committed to institutionalize the long-term groundwater monitoring program in the ODCM and its implementing procedures; Entergy has, in fact, updated the ODCM in accordance with this commitment.

Q.16. Please provide a summary of the radioactive releases and groundwater contamination from spent fuel pools that have been detected at the Indian Point site.

A.16. (JDN) Three separate incidents of leakage from the spent fuel pools have been detected at the Indian Point site. First, leakage from the spent fuel pools at Indian Point Unit 1 was discovered in April 1990.[8] In March 2006, Strontium 90 (Sr-90) was discovered to be present in groundwater at the site, which has been attributed to leakage from the Unit 1 SFPs, given the chemical composition of liquid in the Indian Point Unit 1 spent fuel pools, resulting from differences in Unit 1 fuel cladding (stainless steel) as compared to fuel cladding at Units 2 and 3 (zircaloy). Second, in May 1992, a through-wall leak in the Unit 2 spent fuel pool was detected, upon the observation of boric acid deposits on the outside of the spent fuel building east wall.

[8] Indian Point Unit 1 has six interconnected spent fuel pools plus a water storage pool.

Third, in August 2005, contamination was detected on the underground concrete wall of the spent fuel building. Finally, in June 2007, a through-wall pin-hole leak was discovered in one corner of the Unit 2 SFP transfer canal.

Q.17. Please describe the circumstances related to the Unit 1 spent fuel pool leakage that was found to have occurred at the Indian Point site, identified in your response to Question 16 above, and the actions taken to address that leakage.

A.17. (JDN) The first indication that the Unit 1 spent fuel pools were leaking was in April 1990, when the former licensee (Consolidated Edison Company) operations staff noticed that the frequency of pool refilling, to replace evaporative losses, had increased. Over the next four years, licensee investigations and three NRC inspections (conducted in May-June 1992, August 1992, and December 1994) resulted in confirming a loss rate of 25 gallons per day. In the mid-1990's, the Unit 1 foundation drain discharges were rerouted to enable liquid batch releases to be made from one drain system only, and the former licensee connected the other drain system to the discharge canal with hard piping; a radiation detector was also installed to provide continuous monitoring of this discharge path. In the late 1990's, the former licensee took additional actions to further address the leaking Unit 1 spent fuel pools. These included: removing and shipping all irradiated reactor hardware (all non-fuel materials) from the pools and emptying all pools except the West spent fuel pool (which contained the spent fuel), to further limit the pool leak rate.

In March 2006, during Entergy's investigation of groundwater contamination (discussed below), Sr-90 was identified in a groundwater monitoring well. This was the first indication that leakage from the Unit 1 SFPs was not confined to the foundation drain system and was entering the groundwater and moving west toward the Hudson River. Entergy then took additional action to process the water in the Unit 1 SFPs, by providing continuous demineralization and filtration, and reducing its radioactivity by a factor of approximately 1000, beginning in August 2006. Entergy also expedited its plans for dry storage of the Unit 1 spent fuel and, by November 2008,

it successfully removed all of the spent fuel to onsite dry storage, and completely drained and desludged the Unit 1 spent fuel pools. These actions completely terminated any further leakage of radioactive materials from the Unit 1 SFPs. An NRC inspection performed during the period of August 18 – September 4, 2009 reported on and confirmed the success of these actions *See* Inspection Report 050000003/2009008; 05000247/2009008; 05000286/2009008 (Exhibit ENT000343).

Q.18. Please describe the circumstances related to the Unit 2 spent fuel pool leakage that was found to have occurred at the Indian Point site, identified in your response to Question 16 above, and the actions taken to address that leakage.

A.18. (JDN) In May 1992, the Unit 2 spent fuel pool was discovered to be leaking, based on the observation of visible boric acid deposits accumulating on the outside of the spent fuel building east wall. The former licensee (Consolidated Edison Company) performed an examination of the spent fuel pool, identified the source of the leak, and weld-repaired the leak in June 1992. In addition, the former licensee excavated and removed the contaminated soil around the leak location. The former licensee's investigation determined that this leak was caused by damage to the Unit 2 SFP liner by a diver's cutting torch, during Unit 2 SFP fuel rack modification work in October 1990. The former licensee's corrective actions successfully terminated this leak.

In August 2005, while Entergy was excavating the south wall of the Unit 2 SFP, wet contamination was detected on the exposed underground concrete wall of the spent fuel building. This discovery prompted an investigation, which was then expanded into a site-wide contaminated groundwater investigation. Initially, monitoring wells were installed to map the extent of tritium contamination down-gradient of the Unit 2 SFP. In March 2006, when Sr-90 was detected in groundwater at the site, the investigation was expanded to include the area down-gradient of the Unit 1 SFP. In May 2008, Entergy transmitted a letter (Exhibit NRC000095), in which it undertook to implement a groundwater monitoring program as a license commitment.

During the next two and one-half years, Entergy undertook to develop a hydrogeologic "conceptual site model" and implement a comprehensive site-wide groundwater monitoring network with the assistance of its contractor, GZA Geoenvironmental, Inc. ("GZA"). The licensee's conceptual site model testing of groundwater transport included packer testing of each monitoring well, draw-down testing of a Unit 2 SFP recovery well throughout the groundwater monitoring network, and a dye tracer study to track groundwater transport from the Unit 2 SFP as it was intercepted by each onsite monitoring well.

A further leak involving the Unit 2 SFP was discovered in 2007. In June 2007, Entergy drained the Unit 2 SFP transfer canal for examination. During this examination, Entergy identified a through-wall pin-hole leak in one corner of the transfer canal. This leak was evaluated by a Non-Destructive Examination ("NDE") Level 3 expert and was characterized as an original welding imperfection; no evidence of any corrosion or degradation of the welded surfaces was found. This defect was permanently repaired by the licensee in December 2007, thereby terminating this leak. The NRC verified and inspected these repairs as documented in Inspection Report No. 05000003/2007010; 05000247/2007010 (Exhibit RIV000067).

No leakage has been detected from the Unit 3 spent fuel pool. The Unit 3 SFP (unlike the Unit 2 SFP) was constructed with a leak detection system that is periodically drained to detect leaks. During the 2005-2008 groundwater investigation, Entergy boroscopically examined and cleaned out this leak detection system, verified its continued operability, and confirmed that there were no current leaks from the Unit 3 SFP.

Q.19. Please describe the investigation of groundwater contamination that Entergy has conducted at the Indian Point site following its discovery of a leak from the Unit 2 SFP in 2005.

A.19. (JDN) As indicated in response to Question 18 above, in performing its investigation and monitoring of groundwater contamination at the Indian Point site, Entergy retained the services of GZA Geoenvironmental, Inc.; GZA then conducted a two-year comprehensive hydrogeologic site investigation. As stated in GZA's January 7, 2008 final report,

"Hydrogeologic Site Investigation Report for the Indian Point Energy Center" ("GZA Report") (Exhibit RIV000066), although Entergy's groundwater contamination investigation was initially prompted by the discovery of leakage from the Unit 2 SFP, it was subsequently expanded to include other areas of the site "where credible potential sources of leakage might exist, and encompassed all three reactor units." Exhibit RIV000066, at viii. Further, GZA explained that the purpose of this investigation was to identify the nature and extent of radioactive groundwater contamination; to assess the hydrogeological implications of that contamination; to establish the sources of radioactive groundwater contamination; to evaluate the mechanisms that control transport of the radiological contamination; to estimate the groundwater flow rate and quantify the radioactive contaminants being discharged from the site; to develop a groundwater monitoring network to monitor the existing contaminant plumes; to align with the Nuclear Energy Institute's groundwater protection initiative (NEI 07-07); and to recommend appropriate remedial actions. *Id.* at 1-2.

Q.20. Please summarize the conclusions reached by GZA based on its investigation and monitoring of the groundwater contamination at the Indian Point site.

A.20. (JDN) In its Final Report of January 7, 2008, GZA reported that it had traced the groundwater contamination back to the Unit 1 and Unit 2 spent fuel pools, and that the plumes resulting from the release of radiological materials from the SFPs had commingled in groundwater at the site. Exhibit RIV000066, at viii. GZA characterized these plumes and determined their extent, activity and impacts. *Id.* GZA reported that the two primary radionuclide contaminants found to be of interest were tritium and strontium; other contaminants were found in some of the groundwater samples, but always in conjunction with tritium or strontium. Accordingly, while the focus of GZA's investigation was tritium and strontium, it inherently addressed the full extent of groundwater radionuclide contamination. *Id.*

GZA's investigation resulted in the creation of a detailed hydrogeologic radiological plume map, showing the spatial location and vertical depth of the plume and the concentrations of

radionuclide contamination at the Indian Point site. This map is reproduced in NRC Inspection Report No. 05000003/2007010; 05000247/2007010, Figure 1 (Exhibit RIV000067). GZA found that the contaminated groundwater cannot migrate off-property to the North, East or South, and that the plumes ultimately discharge to the Hudson River to the West. *Id.* In this regard, GZA concluded as follows:

> The groundwater contamination is, and will remain, limited to the Indian Point Energy Center property, because the migration of Site contaminants is controlled by groundwater flow, which, in turn, is governed by the post-construction hydrogeologic setting. Plant construction required reduction in bedrock surface elevations and installation of foundation drains. These man-made features have lowered the groundwater elevations beneath the facility, redirecting groundwater to flow to the West towards the Hudson River; and not to the North, East or South. Because of the nature and age of the releases, groundwater contaminant migration rates, and interdictions by Entergy to eliminate/control releases, the groundwater contaminant plumes have reached their maximum spatial extent and should now decrease over time.

Id. at ix. The Staff's evaluation of GZA's investigation is discussed below, in response to Question 23.

Q.21. Please describe the NRC Staff's efforts to assure that Entergy has adequately investigated and characterized the spent fuel pool leaks that were identified at the Indian Point site.

A.21. (JDN) In response to Entergy's 2006 discovery of groundwater contamination, the NRC Staff established an independent inspection team, for which I served as team leader, The NRC inspection team included NRC experts as well as experts from the U.S. Geological Survey ("USGS") and the New York State Department of Environmental Conservation ("NYSDEC"). The NRC inspection team continually reviewed the licensee's progress, questioned the adequacy of the conceptual site model, and examined the licensee's conclusions. In particular, during quarterly inspections, the NRC team reviewed the iterative progress of the site hydrogeological investigation, and tested an alternative groundwater transport dominated by preferential fracture flow. During the period of 2005 through 2009, the NRC Staff completed

eight team inspections associated with the Indian Point groundwater contamination issue. The results of those inspections are presented in the following Inspection Reports (IR), for which I had primary responsibility:

- IR No. 05000247/2005011, September 13, 2005 – February 28, 2006 (Exhibit RIV000069);
- IR No. 05000247/2006003; 05000286/2006003, June 12-13, 2006 (Exhibit NRC000091);
- IR No. 05000247/2006005; 05000286/2006005, November 13-17, 2006 (Exhibit NRC000092);
- IR No. 05000247/2007002; 05000286/2007002, February 26 – March 21, 2007 (Exhibit NRC000093);
- IR No. 05000247/2007003; 05000286/2007003, May 9-10, 2007 (Exhibit ENT000347);
- IR No. 05000247/2007004; 05000286/2007004, July – August 2007 (Exhibit NRC000094);

  IR No. 05000003/2007010; 05000247/2007010, November 7, 2007 – May 7, 2008 (Exhibit RIV000067); and
- IR No. 050000003/2009008; 05000247/2009008; 05000286/2009008, August 18 – September 4, 2009 (Exhibit ENT000343).

Due to the existence of two possible groundwater flow hypotheses (i.e., fracture flow versus general porous media flow), the NRC Staff's inspection team developed an independent fracture flow groundwater transport evaluation, using down-hole geophysical and flow logs conducted by the USGS. The Staff/USGS analysis calculated a fracture flow groundwater transport flow rate, which the Staff used to compare with the licensee's groundwater flow rate calculations (derived from packer testing data (slug tests) and based on a general porous media groundwater flow model). The USGS file report provided comparable results to those obtained by the licensee, thus confirming the licensee's groundwater transport results using independent data and methods (Exhibit ENT000341).

In addition to performing an independent hydrogeological analysis, the NRC Staff also conducted its own independent groundwater sample testing to confirm the types and concentrations of radioactive contaminants that were present. The NRC inspection team established an independent chain-of-custody sampling program for each of the groundwater sampling points to confirm the identity of any radionuclides that were present and to ensure the accuracy of the licensee's laboratory analysis program; in addition, the NRC inspection team sampled the Unit 2 SFP to readily identify all possible radionuclides present; and the NRC's sampling program was expanded to include Sr-90, Co-60, Ni-63, and Cs-137, in addition to tritium, after Sr-90 and these other radionuclides were found in several monitoring wells.

Further, the Staff performed an independent fish sampling analysis, in conjunction with the State of New York, in order to investigate the Sr-90 background levels present in Hudson River fish far upstream from the Indian Point site, for comparison with Sr-90 levels in fish samples taken near the site. This comparative analysis showed no contamination in any fish samples near the site greater than background levels (attributable to atomic bomb-related testing).

The NRC Staff's inspection team has continued to inspect Entergy's groundwater contamination investigation during the past several years, and will continue to do so in the future. This has included a review of the licensee's final site hydrogeological investigation report (which Entergy submitted in January 2008), and the licensee's Long Term Ground Water Monitoring Plan (submitted in January 2008). In September 2009, the Staff issued its final groundwater-related special inspection report, in which the Staff concluded that the licensee's Final Long Term Ground Water Monitoring Plan was effectively implemented and maintained to monitor groundwater conditions, so as to confirm the licensee's conformance with NRC regulatory requirements to protect public health and safety and the environment. (Inspection Report No. 05000003/2009008; 05000247/2009008; and 05000286/2009008) (Exhibit ENT000343), at page 7.

Q.22. Did the NRC Staff interact with Entergy or GZA during the development and implementation of GZA's hydrogeologic site investigation?

A.22. (JDN) Yes. The NRC Staff's inspection team interacted extensively with the licensee and its contractor, GZA, during this process. Between the fall of 2005 and May 2008 (after the hydrogeologic site investigation report had been issued), NRC team inspections were conducted approximately once per quarter, during which the NRC inspectors met with the Entergy-contracted hydrogeologists to discuss the current conceptual site model of groundwater transport, and challenged the proposed conceptual site model to ensure that appropriate alternative models were investigated. I believe that these iterative inspection reviews helped guide Entergy's efforts and ensured that a comprehensive investigation was conducted. Examples of these interactions include:

- The NRC inspection team proposed assumption of fracture flow-dominated groundwater transport versus Entergy's assumption of general porous media groundwater flow transport; this resulted in the NRC's arrangement for an independent USGS study of fracture flow at the site to compare with the groundwater flux results obtained by the licensee.

- Due to questions of possible continued leaks from the Unit 2 SFP and potential remediation options, the licensee installed a recovery well (RW-1) adjacent to the Unit 2 SFP and conducted a pumping test that provided information concerning draw down connectivity to the existing groundwater monitoring well network.

- The NRC inspection team questioned the conceptual site model's proposal of a "perched" water storage area below the Unit 2 SFP and above the water table. Proof of this proposed model initiated a fluorescein dye tracer test study by the licensee that involved injecting fluorescein dye at the base of the Unit 2 SFP to monitor its movement in the subsurface including the time of transport, which substantiated the licensee's hypothesis of a perched water system below the Unit 2 SFP.

I believe that these iterative challenges and "cross-examinations" of the licensee's site investigation assisted in producing a comprehensive investigation with proof of each assumption and model theory, prior to GZA's issuance of its January 7, 2008 Hydrogeologic Site Investigation Report (Exhibit RIV000066).

Q.23. Has the Staff reached a conclusion regarding the adequacy of Entergy's investigation of groundwater contamination at the Indian Point site?

A.23. (JDN) Yes. Inspection Report No. 05000003/2007010; 05000247/2007010, dated May 13, 2008 (Exhibit RIV000067) provides the NRC Staff's assessment of GZA's Final Report. As described therein, the Staff concluded that Entergy's investigation of groundwater contamination at the Indian Point site (a) provides a reasonable basis for estimating groundwater contaminant discharge flow, (b) shows that contaminant concentration measurements have been effectively determined, and (c) provides a sound understanding of the extent and significance of the radiological contamination of groundwater at the Indian Point site. Further, the hydrogeologic radiological plume map (see Exhibit RIV000067, at Enclosure, Figure 1) which was formulated based upon the results of Entergy's groundwater contamination investigation, provides a sound understanding of the spatial location and vertical depth of the radioactive plume and concentrations of radionuclide contamination at the site.

In addition to investigating existing site contamination, GZA provided an evaluation of remediation options. In this regard, GZA concluded that due to potentially expanding the Unit 1 Sr-90 plume unnecessarily, pumping down the groundwater beneath the Unit 2 SFP would not be desirable, and that monitored natural attenuation would be the most effective option. Exhibit RIV000066, at Pages16-17; Inspection Report No. 05000003/2009008; 50000247/2009008; and 05000286/2009008 (Exhibit ENT000343), at page 5. The Staff's inspection team agreed with this conclusion. In Inspection Report No. 05000003/2009008; 05000247/2009008; and 05000286/2009008, dated October 19, 2009 (Exhibit ENT000343), the Staff's inspection team found that the GZA report constitutes an acceptable technical basis document to support the site groundwater monitoring well network and to help identify potential leaks in the future. This evaluation provided the NRC inspection team with confidence that the long term groundwater monitoring program was sufficient to monitor the existing groundwater contamination plume as well as detect any future leaks to groundwater, so as to limit the offsite groundwater discharge of

radioactive material at Indian Point.

Q.24. Please explain how the concentrations of radioactive materials that are present in the groundwater at the Indian Point site contribute to radiation doses to members of the public.

A.24. (JDN) As described above, the radiological consequences of releases from a nuclear power plant are assessed based on their dose impacts on the hypothetical maximum exposed individual member of the public. Plant-specific exposure pathways – e.g., internal dose from the consumption of various radiologically impacted food supplies (drinking water, fish, crops, and milk), inhalation, and direct exposure from the facility and shoreline deposits – are evaluated and defined in the licensee's Radiological Effluent Technical Specifications and/or Offsite Dose Calculation Manual. Gaseous and liquid releases are sampled, the quantity of radioactivity determined, and the dose contributions from each pathway-to-man are calculated. Using public dose calculation methodology specified in NRC Regulatory Guide 1.109 (Exhibit ENT000339), the maximum dose for four age groups and for total body and maximum organs are calculated and reported annually to the NRC in the licensee's Annual Radioactive Effluent Release Report.

Entergy's Offsite Dose Calculation Manual specifies the site-specific exposure pathways to the public due to radionuclide releases from Indian Point Energy Center. For Indian Point, no direct drinking water pathway has been modeled, as there are no onsite or nearby offsite drinking water wells and nearby sections of the Hudson River are brackish and are not currently used for public drinking consumption. Likewise, there is no downstream irrigation use of the Hudson River. As a result, in Entergy's ODCM, the liquid effluent pathway includes only the postulated consumption of fish and saltwater invertebrates (e.g., crabs) that are harvested from the Hudson River; this factor is used for determining the public dose impact resulting from the discharge of contaminated groundwater from Indian Point into the Hudson River. The corresponding Radiological Environmental Monitoring Program ("REMP") samples fish and invertebrates twice annually, including the area impacted by the plant and a control location 20 miles upstream of

the site. Entergy also samples aquatic plants, Hudson River water and bottom sediment and shoreline soil as well, although these samples represent only environmental indicators rather than pathways to man.

The following Table presents the reported public doses for the six-year period of 2005 – 2010 (the last year for which these data are currently available),[9] for all pathways at Indian Point Units 1, 2 and 3 – including the dose resulting from groundwater contamination at the site:

Table 1

Effluent Release and Total Doses to the Public Due to IPEC Operation

	(a)	(b)	(c)	(d) Sum of Columns (a) - (c)	(e)	(f)	(g)	(h) Sum of Columns (d) – (g)
	Units 1 & 2 liquid routine release total body dose (mrem/yr)	Unit 3 liquid routine release total body dose (mrem/yr)	Ground water release total body dose (mrem/yr)	Total site liquid release total body dose (mrem/yr)	Total site air release total body dose (mrem/yr)	Direct (radiation shine) total body dose (mrem/yr)	C-14 total body dose (mrem/yr)	Total site total body dose (mrem/yr)
2005	8.11E-4	4.45E-4	2.12E-3	3.38E-3	4.87E-3	<4	5.2E-2	<4.06
2006	8.8E-4	1.27E-4	1.78E-3	2.79E-3	1.3E-2	<7	5.2E-2	<7.07
2007	5.35E-4	3.2E-4	2.66E-4	1.12E-3	6.31E-3	<7	5.2E-2	<7.06
2008	6.11E-4	1.56E-4	2.86E-4	1.05E-3	4.06E-3	6	5.2E-2	6.06
2009	9E-4	2.49E-4	2.56E-4	1.4E-3	5.64E-3	5	1.04E-1	5.11
2010	5.18E-4	1.7E-4	1.73E-4	8.61E-4	7.84E-3	6.1E-2	1.25E-1	1.95E-1

As demonstrated in the above Table, for the past six years of reported public doses, the total dose from all pathways at Indian Point Units 1, 2 and 3 (collectively, the Indian Point Energy Center ("IPEC")) – including the dose resulting from groundwater contamination at the site – has consistently been well below the NRC regulatory public dose limits. Further, during this period, the dose contribution from groundwater contamination at the site has consistently been a small fraction of the total dose.[10] In addition, the groundwater plume associated with the Unit 2 SFP

[9] Data for calendar year 2011 are due to be reported by May 15, 2012.

[10] As is also evident in Table 1 above, the trend of dose impacts from groundwater contamination at the Indian Point site shows a general decline in dose over the period 2005-2010. In this regard, it should be noted that during the licensee's hydrogeological investigation (conducted since 2005), various

has shown a decreasing trend in radioactivity, during the three years following Entergy's repair of the Unit 2 SFP transfer canal pinhole leak. In sum, the maximum hypothetical doses from liquid pathways represent approximately 0.1% of the ALARA design objectives for liquid effluents (3 mrem to the total body per year, per reactor) for Units 1 and 2, even with the groundwater releases attributed to the Indian Point Units 1 and 2 spent fuel pools. Comparing these doses to the public dose limit in 10 C.F.R. § 20.1301 (100 mrem TEDE per year), the total site radiation doses to members of the public from the operation of Indian Point Units 1, 2 and 3 are well below regulatory limits with no significant impact on public health and safety.

In addition to assessing the total body doses from all pathways at Indian Point, I have also assessed the calculated maximum organ doses. The maximum hypothetical doses from liquid pathways represent approximately 0.1% of the ALARA design objectives for liquid effluents (10 mrem to the maximum organ per year, per reactor) for Units 1 and 2, even with the groundwater releases attributed to the Indian Point Units 1 and 2 spent fuel pools.

Both the total dose and maximum organ doses are a fraction of the EPA's total body dose and maximum organ dose criteria as provided in 40 C.F.R. Part 190 (25 mrem total body and/or any organ and 75 mrem organ dose to the thyroid). As shown in Table 2 below, the total offsite radiation doses to the maximum organ are well below the NRC ALARA design criteria and EPA limits.

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conservative approximations were made during the first two years until a measured groundwater flow could be determined and more accurate groundwater releases and public doses could be determined. For this reason, the doses reported for 2005 and 2006 are shown to be higher than in later years. Also, late in 2008, the licensee intentionally raised the Unit 1 spent fuel pool water level, in order to be able to unload the spent fuel from the pool prior to subsequent pool drain down. This resulted in a temporary increase in contaminated groundwater leakage and an expected elevated groundwater release in 2009; the effect of that action decreased in 2010 and this downward trend is expected to continue in future years.

Table 2

Effluent Release and Maximum Organ Doses to the Public Due to IPEC Operation

	(a)	(b)	(c)	(d) Sum of Columns (a) - (c)	(e)	(f)	(g)	(h) Sum of Columns (d) –(g)
	Units 1 & 2 liquid routine release maximum organ dose (mrem/yr)	Unit 3 liquid routine release maximum organ dose (mrem/yr)	Ground water release maximum organ dose (mrem/yr)	Total site liquid release maximum organ dose (mrem/yr)	Total site air release maximum organ dose (mrem/yr)	Direct (radiation shine) maximum organ dose (mrem/yr)	C-14 maximum organ dose (mrem/yr)	Total site maximum organ dose (mrem/yr)
2005	1.31E-3	5.38E-4	9.72E-3	1.16E-2	4.87E-3	<4	2.6E-1	<4.28
2006	1.26E-3	1.6E-4	7.21E-3	8.63E-3	1.3E-2	<7	2.6E-1	<7.28
2007	1.3E-3	2.14E-4	9.94E-4	4.43E-3	6.31E-3	<7	2.6E-1	<7.27
2008	1.47E-3	2.83E-4	9.35E-4	2.69E-3	4.66E-3	6	2.6E-1	6.27
2009	1.71E-3	4.59E-4	1.03E-3	3.2E-3	5.64E-3	5	5.2E-1	5.53
2010	1.09E-3	9.73E-4	7.06E-4	2.77E-3	7.84E-3	6.1E-2	6.29E-1	7E-1

Q.25. Did the NRC Staff's inspection team agree with Entergy's conclusion that radioactive groundwater contamination at the Indian Point site will not result in radiological impacts to local drinking water supplies, and that impacts to the Hudson River are limited to human consumption of fish and invertebrates in the river?

A.25. (JDN) Yes. Entergy's groundwater contamination investigation evaluated the site groundwater transport direction, evaluated the location of local drinking water supplies, and determined that the groundwater contamination will have no impact to any public drinking water supply. The closest reservoir (Camp Field) is located 3.3 miles from the site and at an elevation several hundred feet above the site elevation, while the Indian Point groundwater contaminant plume is generally less than 10 feet above sea level. The other local public drinking water supply is the New Croton Reservoir, which is 6.3 miles from the site at about 200 feet above sea level. Both of these public drinking water supplies are several watersheds away from the Indian Point site with higher elevations than the site, and therefore would not be impacted by groundwater contamination at Indian Point.

Entergy also reviewed the other exposure pathways to man (irrigation, recreational activities, and fish consumption) and determined that only the consumption of fish and invertebrates was a viable exposure pathway impacted by the discharge of contaminated groundwater from the site. The NRC inspection team reviewed the bases for these environmental impact assessments and agreed with Entergy's conclusion that the consumption of fish and invertebrates was the only viable exposure pathway. See Inspection Report No. 05000003/2007010 and 05000247/2007010 (May 13, 2008) (ExhibitRIV000067), at pages 7-9.

Q.26. What role, if any, was performed by the NYSDEC in the investigation or inspection of groundwater contamination at the Indian Point site?

A.26 (JDN) Experts from the NYSDEC were directly involved in the NRC Staff's groundwater inspection activities, and they participated actively during the licensee's hydrogeologic site investigation. For example, NYSDEC conducted its own split sample tests of groundwater samples to verify the licensee's results. In addition, NYSDEC and the Staff reviewed the licensee's REMP sampling of fish taken from the Hudson River, resulting in the establishment of a background level of Sr-90 in Hudson River fish, based on the conduct of an extended fish migration population tissue sampling study in June 2007. This tissue sampling study was undertaken to resolve the source of Sr-90 detected in a few fish in both the discharge zone of the plant and the control zone 20 miles upstream; an additional fish sampling location 90 miles upstream was selected by NYSDEC to provide a segregated fish population to measure Sr-90 due to background atomic bomb testing. The results of that study indicated that all positive Sr-90 detections reflected background levels, supporting the conclusion that REMP samples have not detected any Sr-90 in fish due to the operation of the Indian Point facility.

As part of its inspection activities, the NRC inspection team evaluated the groundwater effluent discharge bases as documented in the GZA Report, and the dose calculations based on the Indian Point ODCM. The inspection team found that the licensee's analyses included the dilution of groundwater effluent discharges into the Hudson River in a 6-hour tidal surge of the

river, and that the licensee followed the radionuclide transfer, population segment consumption rates (infant, child, adolescent, adult), and dose conversion factors supplied in Regulatory Guide 1.109 for calculation of the public doses, with one exception, which the NRC inspection team found to be acceptable.[11] Entergy's public dose calculations resulting from fish and invertebrate consumption were independently verified and validated by the NRC inspection team.

Q.27. Is the NRC Staff aware of any continued leakage of radioactive materials from the Indian Point spent fuel pools into groundwater at the site?

A.27. (JDN) To the best of the Staff's knowledge, Entergy has terminated the sources of groundwater contamination, and the Staff is not aware of any evidence of continued leakage from the Indian Point SFPs into groundwater at the site. It should be noted, however, that only 40% of the Unit 2 SFP liner welds have been inspected due to the small wall clearances adjacent to the spent fuel racks that prohibit conventional inspection techniques. Nonetheless, based on a sensitivity analysis of the groundwater monitoring wells, the NRC Staff has determined that if there is any ongoing leakage, it would total no more than 30 gallons per day. This is documented in NRC Inspection Report No. 05000003/2009008; 05000247/2009008; and 05000286/2009008) (Exhibit ENT000343), at page 7.

Ultimately, the detection of leaks from the Unit 2 SFP relies on groundwater well monitoring. In this regard, the associated monitoring wells (MW-30, MW-31, and MW-32) have shown a decreasing trend in tritium concentrations, which are currently approximately 1/3 of the actual tritium concentrations measured in 2005; this trend is indicative of natural attenuation (through groundwater purging and radioactive decay) of the radioactive materials that were released through the SFP leak prior to its repair in 2007. Entergy has committed to continue

[11] In this regard, Entergy utilized a bioaccumulation factor of 224 for fish and invertebrates, rather than the default values specified in Regulatory Guide 1.109 for freshwater fish and invertebrates of 2000 and 1000, respectively, based on measurements performed by the New York University Medical Center ("Radioecological Studies of the Hudson River Progress Report, March 1988"). The NRC inspection team found that the use of this site-specific bioaccumulation factor was appropriate, because the Hudson River near the Indian Point site is not a fresh water body (13% seawater salinity) and Regulatory Guide 1.109 establishes a bioaccumulation factor of "2" for fish and "20" for invertebrates in seawater.

implementation of its groundwater monitoring program in the future. Continued implementation of Entergy's current groundwater monitoring program should be sufficient to detect any change in the spent fuel pool condition, and provides reasonable assurance that Entergy will be able to detect and fix any further leaks that may occur, thus minimizing the potential for any significant offsite groundwater releases in the future.

Q.28. Is the leakage of radioactive materials from the Indian Point spent fuel pools reflected in Entergy's Annual Radioactive Effluent Release Reports ("ARERRs"), issued since 2005?

A.28. (JDN) Yes. Entergy is required to report the quantity of radioactivity released and the dose impact on the public in its ARERRs. Since the Unit 1 and Unit 2 spent fuel pools were identified to be leaking (in March 2006 and September 2005, respectively), Entergy has reported offsite effluent releases from groundwater in its ARERRs, as required. This included quantities of each radionuclide released and the dose impact from these releases on the hypothetical maximum exposed individual member of the public.

Entergy's Annual Radioactive Effluent Release Reports provided official documentation of the groundwater effluent discharges, and provided a regulatory focus for the NRC Staff's inspection activities. The Staff's inspections evaluated the adequacy of the licensee's reports under the NRC's reporting requirements, and compared the reported effluent releases to the ALARA dose objectives in 10 C.F.R. Part 50, Appendix I. The Staff found that Entergy's hydrogeologic investigation established site groundwater flow parameters and an acceptable precipitation mass/flow methodology to calculate the groundwater flux through the contamination impacted areas of the site. This provided a reasonable basis for quantifying the offsite groundwater effluent releases reflected in Entergy's ARERRs.

NRC STAFF'S CONSIDERATION OF RADIOACTIVE RELEASES AND GROUNDWATER CONTAMINATION IN THE FSEIS FOR LICENSE RENEWAL OF INDIAN POINT UNITS 2 AND 3

Q.29. In reviewing Entergy's license renewal application for Indian Point Units 2 and 3, did the Staff consider the potential environmental impacts resulting from the Indian Point spent fuel pool leaks?

A.29. (SPK) Yes. The potential radiological impacts of license renewal, including the radiological impacts resulting from effluent releases, specifically including the spent fuel pool leaks, were considered in the Final Supplemental Environmental Impact Statement for license renewal (Exhibit NYS000133), in FSEIS Sections 2.2.7, 4.3, 4.5, and 4.7.

Q.30. Please describe the information that the Staff considered in the FSEIS for license renewal of IP2 and IP3, concerning the spent fuel pool leaks at the Indian Point site.

A.30. (SPK) In developing the FSEIS for license renewal, the Staff considered all of the available information concerning the radiological impacts of license renewal, including impacts resulting from the spent fuel pool leaks. In this regard, the Staff reviewed Entergy's LRA and Environmental Report; Entergy's responses to Staff RAIs and its Updated FSAR; numerous reports submitted by Entergy to the NRC regarding radioactive effluent releases and radiation doses at the Indian Point site – including its Annual Radiological Environmental Operating Reports ("AREORs") and Annual Radioactive Effluent Release Reports ("ARERRs") for the period 2002-2006 and 2009; the Offsite Dose Calculation Manual for IP2; Entergy's letter of May 15, 2008 ("Remediation and Long Term Monitoring of Site Groundwater") (Exhibit NRC000095) numerous NRC inspection reports concerning radioactive effluent releases and groundwater contamination at the Indian Point site, identified in the testimony above; various documents issued by the State of New York, including annual reports on environmental radiation and Community Fact Sheets containing information on the groundwater investigation at Indian Point conducted by NYSDEC and the New York State Department of Health; the Final Environmental Statement for Indian Point Units 2 and 3 (issued in 1975); the Draft SEIS for IP2

and IP3 (Exhibit NYS000132); and the public comments on radiological impacts that the Staff received during the EIS scoping process and public comments received concerning the DSEIS (see Appendix A to the FSEIS).[12]

Q.31. Did Entergy address the spent fuel pool leaks in the Environmental Report that it submitted with its LRA in April 2007?

A.31. (SPK) Yes. In its Environmental Report, Entergy presented information concerning the spent fuel pool leaks in Section 5.1, "New and Significant Information: Groundwater Contamination." In this regard, an applicant for license renewal is required, under 10 C.F.R. § 51.53(c), to submit certain information in its environmental report concerning the environmental impacts of license renewal; however, as stated in § 51.53(c)(2), the environmental report "need not discuss any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b)."[13] At the same time,

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[12] For example, the Staff responded to public comments regarding the SFP leaks in Appendix A of the FSEIS (Exhibit NYS000133), at pages A-60 to A-62, A-94 to A-97, A-100, A-116 to A-117, A-136 to A-137, and A-143 to A-145.

[13] In 10 C.F.R. § 51.23, the Commission (a) recited its generic determination that spent fuel can be stored onsite or offsite without significant environmental impacts for at least 60 years beyond the term of a renewed license, and (b) stated that a license renewal applicant's environmental report need not discuss any environmental impact of spent fuel storage in the reactor's spent fuel pool:

> **§ 51.23 Temporary storage of spent fuel after cessation of reactor operation—generic determination of no significant environmental impact.**
>
> (a) The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 60 years beyond the licensed life for operation (which may include the term of a . . . renewed license) of that reactor in a combination of storage in its spent fuel storage basin and at either onsite or offsite independent spent fuel storage installations. . . .
>
> (b) Accordingly, as provided in §§ 51.30(b), 51.53 [and] 51.95 . . . , and within the scope of the generic determination in [§ 51.23(a)], no discussion of any environmental impact of spent fuel storage in reactor facility storage pools . . . for the period following the term of the reactor operating license or amendment, . . . is required in any environmental report, environmental impact statement, environmental assessment, or other analysis prepared in connection with the issuance or amendment of an operating license for a nuclear power reactor under parts 50 and 54 of this chapter . . . .

an applicant is required, under 10 C.F.R. § 51.53(c)(3)(iv), to submit any "new and significant information regarding the environmental impacts of license renewal of which the applicant is aware." Accordingly, Entergy identified the SFP leaks and groundwater contamination at the Indian Point site as "new" information; Entergy concluded, however, that the new information was not "significant" based on the facts known at the time it submitted its ER.

Q.32. Did the Staff consider the information presented in Entergy's Environmental Report concerning the SFP leaks, in the Final SEIS?

A.32. (SPK) Yes. The Staff's FSEIS considered the information reported by Entergy in its ER concerning the leaks and their radiological impacts, as well as Entergy's determination that this information was "new", but not "significant". For example, in Section 2.2.7 of the FSEIS, the Staff summarized the information and conclusions reached by Entergy, as follows:

> In August of 2005, Entergy discovered tritium contamination in groundwater outside the IP2 spent fuel pool (SFP). As a result, Entergy began an on-site and off-site groundwater monitoring program (in September of 2005) in addition to the routine REMP. Entergy used this monitoring program to characterize the on-site contamination, to quantify and determine its onsite and off-site radiological impact to the workers, public and surrounding environment, and to aid in identification and repair of any leaking systems, structures or components.
>
> In Section 5.1 of its ER, Entergy identified the release of radionuclides to groundwater as a potentially new issue based on NRC staff analysis in a previous license renewal proceeding. In its discussion of the issue, Entergy concluded that the radionuclide release does not affect the onsite workforce, and that Entergy anticipated the leakage would not affect other environmental resources, such as water use, land use, terrestrial or aquatic ecology, air quality, or socioeconomics. In addition, Entergy asserted that no NRC dose limits have been exceeded, and EPA drinking water limits are not applicable since no drinking water exposure pathway exists.

Q.33. Did the Staff base its evaluation and conclusions in the FSEIS, regarding the environmental impacts of the spent fuel pool leaks at Indian Point for purposes of license renewal, solely on the information and assessment in Entergy's Environmental Report?

A.33. (SPK) No. While the Staff considered the information and environmental assessment provided by Entergy concerning the SFP leaks and their radiological impacts, the Staff considered much more information in evaluating the radiological impacts of license renewal. As stated above, this included reviewing, among other things, Entergy's Annual Radiological Environmental Operating Reports (which include a description of its radiological environmental monitoring program), Entergy's Annual Radioactive Effluent Release Reports, publications by the State of New York, and numerous inspection reports issued by the NRC Region I groundwater inspection team.

Q.34. Please describe the radiological environmental monitoring program (REMP) and any additional monitoring that has been conducted at Indian Point that the Staff considered in the FSEIS for license renewal of Indian Point Units 2 and 3.

A.34. (SPK) Nuclear power plant licensees are required to conduct radiological monitoring of the environment, pursuant to Criterion 64 of Appendix A to 10 C.F.R. Part 50. In performing its evaluation of the potential impacts to members of the public from radioactive effluent releases, the Staff generally reviews five years of the applicant's annual reports containing data on radioactive effluents and radiological environmental monitoring data. The use of a five year period is consistent with the guidance contained in the Staff's Environmental Standard Review Plan, Supplement 1 (NUREG-1555, Supp. 1) (Exhibit NYS00019B), at 2.2.7-4. Also, a five year period provides a representative data set that covers a broad range of the activities that typically occur at a nuclear power plant, such as refueling outages, non-refueling outage years, routine operation, and years in which there may be significant maintenance activities. In reviewing these data, the Staff seeks to determine whether radiological conditions at the plant have been steady, without measurable impact to the environment from plant operations, and whether there are any trends showing an increase or decrease in radioactive effluent discharges or the build-up of radioactivity in the environment around the plant site.

Environmental monitoring and surveillance have been conducted at the Indian Point site since 1958, which was four years prior to the start-up of Unit 1. The pre-operational program was designed and implemented to determine the background radioactivity and to measure the variations in radioactivity levels from natural and other sources in the vicinity, as well as fallout from nuclear weapons tests. The radiological data obtained by the former licensee (as well as by Entergy) include both natural and anthropogenic sources of environmental radioactivity. The background environmental data permit the detection and assessment of the levels of environmental activity attributable to plant operations.

Under its current licenses, Entergy conducts a radiological environmental monitoring program for the Indian Point site. In accordance with 10 C.F.R. Part 50, Appendix A, Criterion 64, the REMP seeks to assess the radiological impacts to the environment and the public around the Indian Point. The objectives of the REMP are (1) to enable the identification and quantification of changes in the radioactivity of the area, and (2) to measure radionuclide concentrations in the environment attributable to operations of the Indian Point site. Entergy summarizes the results of its REMP in its Annual Radiological Environmental Operating Reports.

Entergy's REMP samples environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the Indian Point site. Direct radiation pathways include radiation from buildings and plant structures, airborne material that might be released from the plant, cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air and water. The REMP designates sampling locations for the collection of environmental media for analysis. These sample locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of environmental radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges. The use of indicator

and control locations enables the identification of potential sources of detected radioactivity as either background or from plant operations. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents.

Entergy's analysis of thermoluminescent dosimeters (TLDs), used to measure direct radiation, indicated that there were no increased radiation levels attributable to plant operations during the 2009 reporting period. The airborne pathway includes measurements of air, precipitation, drinking water, and broad leaf vegetation samples; Entergy's REMP shows that there were no increased radiation levels attributable to airborne material from the Indian Point site during the 2009 reporting period. The waterborne pathway at Indian Point consists of Hudson River water, fish and invertebrates, aquatic vegetation, bottom sediment, and shoreline soil; Entergy's REMP shows there were no significant radiological impacts resulting from the waterborne pathway during the 2009 reporting period.

The Applicant's 2009 REMP results demonstrate the relative contributions of different radionuclide sources, both natural and anthropogenic, to the environmental concentrations. The results indicate that the fallout from previous atmospheric weapons testing continues to contribute to detection of Cs-137 in some environmental samples. There are infrequent detections of plant related radionuclides in the environs; however, the radiological effects are very low and are significantly less than those from natural background and other anthropogenic sources.

As discussed above, nuclear power plant licensees are required to submit both an ARERR (for radiological effluent releases) and an AREOR (for radiation monitoring). The REMP supplements the radioactive effluent release program by verifying that any measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than those calculated using the radioactive effluent release measurements and transport models. Further, the REMP provides an indication of the appearance or accumulation of radioactive material in the environmental that may have been caused by the operation of the nuclear power

plant. It also is used to provide documentation the plants are operating in accordance with NRC requirements. Entergy's 2009 REMP, like the 2002-2006 REMP results, showed no significant radiological impacts to the environment resulting from plant operations. Overall, the results of the 2009 REMP were comparable to historical REMP results.

In addition to conducting its normal REMP, in September 2005 Entergy began implementation of an onsite and offsite ground water monitoring program in response to the discovery of tritium contamination in the groundwater near the Unit 2 spent fuel pool. Additional monitoring actions were developed as part of the site's groundwater monitoring program, which supplements the existing REMP to monitor potential impacts of site operations throughout the license renewal term and to monitor potential impacts of site operations and waste and effluent management programs. This monitoring was added by Entergy to assure that all pathways were being evaluated. The groundwater monitoring program is used to characterize the onsite contamination, to quantify and determine its onsite and offsite radiological impact to the workers, public and surrounding environment, and to aid in identification and repair of any leaking systems, structures or components.

In January 2008, Entergy submitted a report to the NRC, summarizing the findings and conclusions of its investigation that it had initiated following the 2005 discovery of SFP leaks and groundwater contamination (i.e., the GZA Report, discussed in the testimony of James Noggle above). In its accompanying letter dated January 11, 2008 (Exhibit ENT000371), Entergy stated that it had characterized and modeled the affected groundwater regime, identified the sources of leakage, and determined the radiological impacts resulting from the leakage. In addition, Entergy reported that it had begun a long-term groundwater monitoring program and had initiated a remediation program to address the site groundwater conditions. Further, Entergy stated that it had performed radiological dose impact assessments and that it will continue to perform them, and will report the results in its Annual Radiological Effluent Release Reports. Entergy's investigation concluded that the only notable dose pathway resulting from contaminated

groundwater migration to the Hudson River is through the consumption of fish and invertebrates from the river, and the resultant calculated dose to a member if the public is below 1/100 of regulatory limits.

The results of Entergy's groundwater investigation and groundwater monitoring program are summarized in the testimony of James Noggle, above. The Staff considered those results, along with the information obtained from the REMP and AREORs, in evaluating the radiological impacts of license renewal, as primarily set forth in Sections 2.2.7, 4.3 and 4.7 of the FSEIS for Indian Point Units 2 and 3 (Exhibit NYS000133).

Q.35. Please describe how the Staff considered information from Entergy's radiological environmental monitoring program in evaluating the radiological impacts of license renewal of Indian Point Units 2 and 3.

A.35. (SPK) The Staff performed its review in accordance with NUREG-1555, Environmental Standard Review Plan, Supplement 1 (NUREG-1555, Supp. 1) (Exhibit NYS00019B) (discussed in response to Question 34 above). For the Draft SEIS (Exhibit NYS000132), I reviewed Entergy's annual radiological environmental operating reports for a five-year period (2002-2006), in evaluating the radiological environmental monitoring data around the Indian Point site. For the Final SEIS, I also reviewed the 2009 annual report, due to the length of time that had elapsed since issuance of the Draft SEIS. The results of my review are reported in the Final SEIS in sections 2.2.7, Radiological Impacts, and 4.3, Radiological Impacts of Normal Operations (Exhibit NYS000133). My review looked for significant impacts (i.e., concentrations of radioactive material above the NRC's reporting levels contained in Entergy's ODCM) and any adverse trends in the data (e.g., sustained increasing radioactivity levels over several years of monitoring that could eventually exceed regulatory limits.

Q.36. Please describe the Staff's conclusions regarding the radiological impacts resulting from operation of Indian Point Units 2 and 3, based on your review of the REMP results.

A.36. (SPK) In FSEIS Section 2.2.7 ("Radiological Impacts"), the Staff presented its evaluation of the radiological impacts of license renewal. Therein, the Staff stated:

> Based on the NRC Staff's review of the applicant's historical and 2009 REMP data, no unusual trends were observed, and the data showed that there was no significant radiological impact to the environment from operations at the IP2 and IP3 site. Small amounts of radioactive material (i.e., tritium, cesium-137, iodine-131, and strontium-90) were detected that are below NRC's reporting values for radionuclides in environmental samples. Overall, the results were comparable to historical REMP results.

Exhibit NYS000133, at 2-109. In sum, based on the evaluation presented in Section 2.2.7 of the FSEIS, the Staff has concluded that the environmental impacts from radioactive discharges from IP2 and IP3 have not been significant, and there is no evidence of an upward trend in radiological impacts from operation of the facility. Further, in Section 4.3 of the FSEIS, the Staff concluded that the "new" information presented by Entergy (i.e., groundwater contamination) is not significant, and thus does not challenge the generic findings in the GEIS—in which the Commission concluded that the impacts to human health resulting from radiological releases during the license renewal term are SMALL.

Q.37. Please describe how the Staff considered Entergy's Annual Radiological Effluent Release Reports (ARERRs) in evaluating the radiological impacts of license renewal of Indian Point Units 2 and 3.

A.37. (SPK) In accordance with NRC Regulatory Guide 1.21 (Exhibit NRC000100), a licensee's ARERR is required to contain data on the licensee's radioactive gaseous and liquid effluents and solid wastes during the reporting period, to enable the licensee and NRC Staff to evaluate the radiological consequence of plant operation.[14] For the Draft SEIS, I reviewed

[14] Regulatory Guide 1.21 provides, in pertinent part, as follows:

> Information on the identity and quantity of radionuclides in liquid and gaseous effluents and solid wastes from light-water-cooled nuclear power plants, together with meteorological data representative of principal release points, are needed:
>
> 1. For evaluation by the licensee and the Regulatory staff of the

Entergy's 2002 – 2006 Annual Radioactive Effluent Release Reports; for the Final SEIS, I also reviewed the 2009 Annual Radioactive Effluent Release Report. I reported the 2009 dose data in FSEIS Section 2.2.7 ("Radiological Impacts"). Entergy's annual radioactive effluent release reports contain data on the types and amounts of radioactive gaseous and liquid effluents released into the environment and the calculated dose to a hypothetical maximally exposed member of the public from those effluents, during each of the reporting periods.

For the evaluation of the potential radiological impacts to the public from radioactive effluent releases, the NRC's guidance in Regulatory Guide 1.109 (Exhibit ENT000339) explains which radioactive effluent release pathways should be used when performing dose calculations to members of the public. The guidance addresses typical plant effluent release points and exposure pathways through which radioactive materials can impact the public from routine radioactive effluent discharges. The guidance does not explicitly address releases due to unknown leaks, but does provide for consideration of "other exposure pathways that may arise due to unique conditions at a specific site." *Id.* at 1.109-2.

During my review of Entergy's annual radioactive effluent release reports, I noted that Entergy amended its offsite dose calculation manual (ODCM) to include the radioactive material from the spent fuel pool leaks as a new effluent release pathway, and to calculate the dose to members of the public from this pathway. Entergy's inclusion of this pathway in its ODCM was consistent with the guidance in Regulatory Guide 1.109; assures that any further leaks from the SFPs, if they occur, will be monitored and addressed by the licensee; and assures that future

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> environmental impact of radioactive materials in effluents and solid wastes, including estimates of the potential annual radiation doses to the public;
>
> 2. To ascertain whether AEC regulatory requirements and limiting conditions of operation have been met and whether concentrations of radioactive materials in liquid and gaseous effluents have been kept as low as practicable;
>
> 3. For evaluation by the licensee and the Regulatory staff of the adequacy and performance of containment, waste treatment methods, and effluent controls.

Exhibit NRC000100, at 1.21-2.

NRC inspections would verify Entergy's continued monitoring of this pathway and its compliance with NRC dose limits. Further, I found that Entergy's identification of the consumption of fish in the Hudson River as the only human pathway for the contaminated ground water from the SPF leaks was appropriate. In this regard, I reviewed Entergy's data and evaluation, the NRC Region I inspection reports, and New York State's fact sheets to conclude that there were no drinking water sources impacted by the leak.

The NRC Region I inspection team also discussed the change made by Entergy to its ODCM, in its inspection report issued on May 13, 2008 (Exhibit RIV000067). In this regard, the inspection report noted that Entergy had included the radioactive material from the spent fuel pool leaks in its ODCM dose calculations. The inspection report states the following:

> The inspectors concluded that the licensee's preliminary offsite dose calculation utilized conservative assumptions regarding the Unit 2 SFP leak rate and groundwater dilution, appropriately applied the methodology of the licensee's Offsite Dose Calculation Manual, provided a timely dose evaluation response to the identified condition.

The NRC inspection team's assessment of this matter supports the position stated in the Final SEIS, that the calculated doses from the spent fuel pool leak were properly considered by the Applicant, and that the doses are within NRC requirements and thus, are not significant. While the radioactive effluent from the SFP leaks constitutes a new pathway as compared to the routine effluent release pathways described in Entergy's earlier ODCM, the radiological dose to members of the public resulting from this pathway, as independently evaluated by Entergy and the Staff, is not significant.

The Staff's evaluation of the radiological effluent releases from IP2 and IP3 into the environment found that the calculated doses to members of the public in the vicinity of the Indian Point site were a small fraction of the limits specified in the IP2 and IP3 ODCM to meet the dose design objectives in Appendix I to 10 C.F.R. Part 50, as well as the radiation dose limits in 10 C.F.R. Part 20 and EPA's standards in 40 C.F.R. Part 190. This is shown in Tables 1 and 2

above. For example, the 2009 calculated maximum total body dose to an offsite member of the public from all radioactive emissions (radioactive gaseous and liquid effluents, direct radiation shine, and the new liquid effluent release pathway) from the IP2 and IP3 site was 5.11 mrem (5.11 $x10^{-2}$ mSv), which is well below EPA's 25 mrem (0.25 mSv) limit in 40 C.F.R. Part 190. For the site's combined groundwater and storm drain pathway, the calculated maximum total body dose to an offsite member of the public was 2.56 $x10^{-4}$ mrem (2.56 $x10^{-6}$ mSv); the calculated doses for all liquid effluents, including those from the new liquid effluent release pathway from the spent fuel pools, total 1.4 x 10^{-3} mrem. These results confirm that the Indian Point site is in compliance with Federal radiation protection standards contained in Appendix I to 10 C.F.R. Part 50, 10 C.F.R. Part 20, and 40 C.F.R. Part 190.

In sum, the Staff found that Entergy's annual radioactive effluent release reports support the conclusion that (a) calculated doses to members of the public from radioactive effluents, including the radioactive material from the spent fuel pool leaks are well within the NRC dose limits in 10 C.F.R. Part 20, and (b) radioactive effluent releases, including leaks from the Indian Point SFPs, meet the ALARA criteria in Appendix I to 10 C.F.R. Part 50. This assessment is consistent with the conclusion in the GEIS for license renewal – i.e., the radiological impacts to human health resulting from radioactive effluent releases are expected to be SMALL,[15] given the expectation and requirement that nuclear power plants must comply with the NRC's radiation protection standards. GEIS (Exhibit NYS000131) at xlii and xlvi-xlvii. In this regard, the Commission concluded as follows:

[15] As explained in the GEIS, each environmental impact of license renewal was assigned one of three significance levels – "SMALL," "MODERATE," or "LARGE." SMALL impacts are defined as follows:

> SMALL— For the issue, 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 that do not exceed permissible levels in the Commission's regulations are considered small.

GEIS (Exhibit NYS000131), at xxxv.

> The Atomic Energy Act requires NRC to promulgate, inspect, and enforce standards that provide an adequate level of protection of the public health and safety and the environment. . . . [H]ealth impacts on individual humans are the focus of NRC regulations limiting radiological doses. A review of the regulatory requirements and the performance of facilities provides the bases to project continuation of performance within regulatory standards. For the purposes of assessing radiological impacts, the Commission has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the Commission's regulations. This definition of "small" applies to occupational doses as well as to doses to individual members of the public. Accidental releases or noncompliance with the standards could conceivably result in releases that would cause moderate or large radiological impacts. Such conditions are beyond the scope of regulations controlling normal operations and providing an adequate level of protection. Given current regulatory activities and past regulatory experience, the Commission has no reason to expect that such noncompliance will occur at a significant frequency. To the contrary, the Commission expects that future radiological impacts from the fuel cycle will represent releases and impacts within applicable regulatory limits.

GEIS (Exhibit NYS000131), § 4.6, “Radiological Impacts of Normal Operation,” at pages 4-84 – 4-85; emphasis added.

Q.38. Please describe how the Staff considered the NRC Region I inspection reports in evaluating the radiological impacts of license renewal of Indian Point Units 2 and 3.

A.38. (SPK) As stated above, the Staff’s FSEIS evaluation of the radiological impacts of license renewal for Indian Point included consideration of the NRC Region I inspection reports. In this regard, the inspection reports issued by NRC Region I provide a significant source of independently obtained information and independent expert evaluation concerning the Indian Point SFP leaks. The NRC Region I staff performed an extensive inspection of Entergy’s actions to respond to the leaks and independently assessed the adequacy of Entergy’s groundwater monitoring program. The inspection reports provide independently obtained information and an independent evaluation of the spent fuel pool leaks and the associated radiological impacts, from September 1, 2005 (when Entergy informed the NRC that cracks in a Unit 2 spent fuel pool wall had been discovered during excavation work) to May 13, 2008, when the final NRC inspection

report was issued (Exhibit RIV000067).

The NRC inspection team's final report, dated May 13, 2008, contains a number of important findings concerning the radiological impacts of the spent fuel leaks. These include, in part, the following inspection team findings:

- The current contaminated groundwater conditions at Indian Point Energy Center are the result of leakage associated with the Unit 1 and Unit 2 spent fuel pool (SFP) systems. No other systems, structures, or components were identified as contributors to the continuing on-site contamination of ground water.

- Entergy's hydrogeologic site characterization studies provided sufficiently detailed field observations, monitoring, and test data which supported the development and confirmation of a reasonable conceptual site model of groundwater flow and transport behavior. An independent analysis of groundwater transport through fractured bedrock utilizing geophysical well logging data was conducted by the U.S. Geological Survey (USGS). The USGS assessment corroborated the groundwater transport characteristics that were determined by Entergy's contractor.

- Entergy's hydrogeologic site characterization and developed conceptual site model provide a reasonable basis to support the determination that the liquid effluent releases from the affected spent fuel pool systems migrate in the subsurface to the west, and partially discharge to the site's discharge canal, with the remainder moving to the Hudson River. Current data and information indicates that contaminated groundwater from the site does not migrate off-site except to the Hudson River. This conceptual site model of groundwater behavior and flow characteristics is supported by the results of independent groundwater sampling and analyses conducted by NRC, which have not detected any radioactivity distinguishable from background in the established on-site boundary monitoring well locations, or in various off-site environmental monitoring locations.

- Currently, there is no drinking water exposure pathway to humans that is affected by the contaminated groundwater conditions at Indian Point Energy Center. Potable water sources in the area of concern are not presently derived from groundwater sources or the Hudson River, a fact confirmed by the New York State Department of Health. The principal exposure pathway to humans is from the assumed consumption of aquatic foods (i.e., fish or invertebrates) taken from the Hudson River in the vicinity of Indian Point that has the potential to be affected by radiological effluent releases. Notwithstanding, no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish

and crabs taken from the affected portion of the Hudson River and designated control locations.

- The annual calculated exposure to the maximum exposed hypothetical individual, based on application of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," relative to the liquid effluent aquatic food exposure pathway is currently, and expected to remain, less than 0.1 % of the NRC's "As Low As is Reasonably Achievable (ALARA)" guidelines of Appendix I of Part 50 (3 mrem/yr total body and 10 mrem/yr maximum organ), which is considered to be negligible with respect to public health and safety, and the environment.

- All identified liner flaws in the Unit 2 spent fuel pool, and the initially identified crack affecting the Unit 2 spent fuel pool system have been repaired or mitigated. However, not all Unit 2 fuel pool surfaces are accessible for examination. No measurable leakage is discernable from evaporative losses based on Unit 2 fuel pool water makeup inventory data. Unit 1 spent fuel pool water is being processed continuously to reduce the radioactive concentration at the source prior to leakage into the groundwater, and actions have been initiated to effect the complete removal of spent fuel and essentially all the water from the Unit 1 Spent Fuel Pool system by the end of 2008, thereby terminating the source of 99.9% of the dose significant strontium-90 and nickel-63 contaminants (the remaining 0.1% is represented by the Unit 2 and Unit 1 hydrogen-3 (tritium) contaminants). Entergy's selected remediation approach for the contaminated groundwater conditions appears reasonable and commensurate with the present radiological risk.

Exhibit RIV000067, at pages vi-viii. In addition, the inspection team reached the following conclusion regarding the radiological impacts of the SFP leaks and groundwater contamination:

> No off-site groundwater has been impacted, since the on-site groundwater flow is to the discharge canal and the Hudson River. Accordingly, the licensee has established a long-term monitoring strategy for the purpose of evaluating the effect and progress of the natural attenuation of residual contamination, informing and confirming groundwater behavior as currently indicated by the existing site conceptual model, and determining changes in conditions that may be indicative of new or additional leakage. . . .
>
> Notwithstanding, radiological significance from the groundwater conditions at Indian Point is currently, and is expected to remain negligible with respect to impact on public health and safety and the environment. NRC has confirmed with the New York State Department of Health, that drinking water is not derived from groundwater or the Hudson River in the areas surrounding or

> influenced by effluent release from Indian Point. Accordingly, the only human exposure pathway of merit is from the possible consumption of aquatic foods from the Hudson River, such as fish and invertebrates. Dose assessment of the potential for exposure from this pathway, continues to indicate that the hypothetical maximally exposed individual would be subject to no more than a very small fraction of the NRC regulatory limit for liquid radiological effluent release.

Id. at v-vi.

In sum, the NRC Region I inspection team performed an extensive inspection of Entergy's actions to respond to the abnormal leakage, its groundwater monitoring program, and its assessment of the radiological consequences of the leaks. A detailed discussion of the NRC inspection team's activities and findings is presented in the testimony of James Noggle, above. Based upon its evaluation of the SFP leaks and groundwater contamination, the NRC inspection team concluded that the leaks do not have a significant dose impact or a significant adverse impact on public health and safety:

> Our inspection determined that public health and safety has not been, nor is likely to be, adversely affected, and the dose consequence to the public that can be attributed to current on-site conditions associated with groundwater contamination is negligible.

Exhibit RIV000067, transmittal letter at 1-2.

It should be noted that the NRC Region I inspections were conducted as part of the NRC's ongoing regulatory oversight program, rather than as a "one-time" inspection. The Region I inspections of Entergy's radiation protection and groundwater monitoring programs will continue indefinitely in the future, providing additional assurance that the radiological impacts of plant operation will be small, provided that the radioactive releases are maintained within NRC regulatory limits. This is consistent with the conclusion in the GEIS, that compliance with the NRC's radiation protection regulations will assure that the radiological impacts of nuclear power plant license renewal are SMALL. GEIS (Exhibit NYS000131), at 4-84.

In the FSEIS for license renewal of Indian Point Units 2 and 3, the Staff reviewed the

NRC inspection team's findings and conclusions, and found that they provide an important source of independent verification and assessment of Entergy's investigation and analysis of the SFP leaks and groundwater contamination and the associated radiological impacts. The inspection team's findings and conclusions thus support the conclusions reached in the FSEIS regarding the radiological impacts of the SFP leaks and groundwater contamination for purposes of license renewal.

Q.39. Please describe how the Staff considered information generated by the State of New York in evaluating the environmental impacts of the SFP leaks at Indian Point for purposes of license renewal.

A.39. (SPK) As stated above, during my review I considered various materials issued by the State of New York; these included comments by various New York agencies and officials on the Draft SEIS (which were addressed in the FSEIS), as well as a "Community Fact Sheet" issued by the State of New York (Exhibit ENT000325). The "Community Fact Sheet" contained information on the groundwater investigation at Indian Point that was conducted by the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH). The fact sheet stated that New York had performed an independent assessment of potential public impacts of the SFP leaks, and reported that New York had reached the following conclusions:

- "There are no residential or municipal drinking water wells or surface reservoirs near the plant."
- "There are no known impacts to any drinking water source."
- "No contaminated groundwater is moving towards surrounding properties."
- "Contaminated groundwater is moving into the Hudson River."
- "Public exposure can occur from the groundwater entering the Hudson River through consumption of fish."

- "The DOH has confirmed Entergy's calculated dose to humans from fish."
- "Sr-90 levels in fish near the site (18.8 pCi/kg) are no higher than those in fish collected from background locations across the state."
- "At present, there are no off-site groundwater impacts, and releases of contaminated groundwater to the river do not violate state surface water standards for H-3 (20,000 pCi/l) and Sr-90 (8 pCi/l)."

(Exhibit ENT000325), at 1-2. The State of New York's conclusions, based upon its own independent assessment of this matter, are consistent with the findings in the NRC Region I inspection report and my own review of Entergy's annual radioactive effluent release reports and annual radiological environmental monitoring data reports. New York's findings and conclusions thus support the Staff's evaluation and conclusions in the FSEIS, that the environmental impacts resulting from the spent fuel pool leaks at IP2 and IP3 are not significant.

Q.40. Based on the Staff's evaluation of all available information concerning the spent fuel pool leaks at Indian Point, please describe the Staff's conclusions regarding the potential environmental impacts of radioactive effluent releases or "radionuclide leaks" from the Indian Point spent fuel pools.

A.40. (SPK) The Commission has previously determined, as set forth in the GEIS (Exhibit ENT000131), and Table B-1 of 10 C.F.R. Part 51, Appendix B that radioactive releases from nuclear power plants have only a "SMALL" impact on members of the public, provided the doses are within the NRC dose limits established by the Commission in 10 C.F.R. Part 20, "Standards for Protection Against Radiation."

For Indian Point, the radioactive releases resulting from the SFP leaks were considered on a site-specific basis. As discussed in Sections 2.2.7, 4.3 and 4.7 of the Final SEIS and the testimony presented herein, the Staff has concluded that: (1) the radiological effluent releases from the spent fuel pool leaks at IP2 and IP3 result in calculated doses to the maximally exposed member of the public that are well below the Commission's ALARA design objectives stated in

10 C.F.R. Part 50, Appendix I; (2) the radiation doses resulting from the SFP leaks are well within NRC radiation dose limits in 10 C.F.R. Part 20; and (3) the SFP leaks do not have a significant environmental impact and are unlikely to have a significant environmental impact in the event that the IP2 and IP3 licenses are renewed. Accordingly, the Staff has concluded that the SFP leaks at Indian Point will have no more than a "SMALL" impact on members of the public, if the operating licenses for Indian Point Units 2 and 3 are renewed.

RESPONSE TO INTERVENORS' TESTIMONY AND EXHIBITS

Q.41. Have you reviewed (a) the "Pre-filed Direct Testimony of Arnold Gundersen Regarding Consolidated Contention RK-EC-3/CW-EC-1 (Spent Fuel Pool Leaks)" ("Gundersen Testimony") (Exhibit RIV000060), as modified by the Board's Order on Entergy's motion in limine of March 6, 2012,[16] (b) the "Pre-filed Written Testimony of Gillian Stewart Regarding Contention RK-EC-3/ CW-EC-1 (Spent Fuel Pool Leaks)" ("Stewart Testimony") (Exhibit RIV000061), and (c) the other exhibits filed by Riverkeeper and Clearwater regarding Contention RK-EC-3/ CW-EC-1 (*i.e.,* Exhibits RIV000062 through RIV000101)?

A.41. Yes.

Q.42. Based on your review of Mr. Gundersen's and Stewart's testimony and the other exhibits filed by Riverkeeper and Clearwater regarding Contention RK-EC-3/CW-EC-1, have you changed your opinion regarding Entergy's and the Staff's evaluation of the environmental impacts of the spent fuel pool leaks at Indian Point?

A.42. No. Based on our review of the contention, Dr. Stewart's and Mr. Gundersen's testimony, and the Intervenors' other exhibits, we have concluded that Entergy and the Staff have properly evaluated the environmental impacts of radionuclide leaks and radioactive releases from spent fuel pools at Indian Point on groundwater and the Hudson River ecosystem.

Q.43. Do you agree with Mr. Gundersen's assertion, at pages 6-7 of his testimony, that

[16] "Order (Granting in Part and Denying in Part Applicant's Motions in Limine)" (March 6, 2012).

"[t]he Unit 2 SFP has continued to experience leakage since Entergy's discovery of cracks in the pool wall in 2005, and is apparently still actively leaking" (citing the 2010 discovery of "a leak path from light boxes near the top of the SFP"), and that "only a temporary repair to this leak path has been applied"?

A.43. (JDN) No. The light boxes are located above the normal water level of the pool. During spent fuel discharge campaigns (i.e., transfers to dry cask storage), placement of a spent fuel cask into the pool can displace significant amounts of water, and the light boxes can be submerged. Also, there were previously no administrative controls to limit the maximum fuel pool level during fuel pool filling procedures, which also provided the possibility for light boxes to be submerged. When this conditional leak path was identified, all eight light boxes were sealed with epoxy cement and the above-mentioned fuel pool activities were revised to include administrative controls to limit the maximum water level in the pool to below the light boxes during those activities. This provided two barriers to ensure that the light boxes would no longer provide a leak pathway. After currently scheduled fuel discharge campaigns are complete, Entergy plans to take corrective actions to remove the light boxes completely and weld stainless steel panels over these areas. Accordingly, this should not be considered to be a current or future source of active leakage.

Q.44. Do you agree with Mr. Gundersen's assertions, at pages 7-8 of his testimony, that it is not possible to completely rule out other potential leaks in the Unit 2 SFP, due to Entergy's inability to perform a complete pool liner inspection?

A.44. (JDN) Yes, with limitations. During the NRC Staff team inspections, the Staff performed boric acid loss mass balance calculations that, based on limits of sensitivity, indicate that no more than 25 gallons per day was leaking prior to repair of the pin-hole leak in the transfer canal.[17] Also, Entergy has installed three monitoring wells around the Unit 2 SFP, and

[17] This inspection technique measures the concentration of boric acid in the pool, to indicate the amount of water that has been lost due to leakage. This technique provides an effective analytical tool,

this augmented groundwater monitoring network provides another method of leak detection. Based on our inspection review, the detection sensitivity of these monitoring wells would limit any undetected fuel pool leak to no more than 30 gpd (about 1/8 cup per minute).

In our earlier NRC inspection team reports, the NRC Staff remained open to the possibility of continued leakage below the mentioned level of detection sensitivity. By 2009, however, we had over two years of monitoring well data for review to observe tritium concentration changes over time. Based on this review, we observed a decreasing trend over that period, with tritium levels down-gradient of the Unit 2 SFP decreasing by 66% (from 220,000 pCi/L down to 75,000 pCi/L) over the two year time period. Based on this evidence, we concluded in our October 19, 2009 inspection report (Exhibit ENT000343), at pages 6-8, that there is no evidence of any significant large flux active leakage above the 30 gpd detection threshold, and that Entergy's Long Term Ground Water Monitoring Program provides appropriate monitoring and control measures for assessing the existing ground water conditions at the site.

Q.45. Do you agree with Mr. Gundersen's assertion, at pages 9-10 of his testimony, that Entergy's groundwater monitoring program (which employs quarterly testing), is not sufficient to detect future leaks from the Unit 2 SFP, citing the discovery of a new leak in 2010?

A.45. (JDN) No. During our NRC team inspections, expert hydrogeologists from the NRC Office of Nuclear Regulatory Research ("RES"), the U.S. Geological Survey, and the NYSDEC reviewed the frequency of testing in Entergy's monitoring program. Based on the measured movement of groundwater onsite, this frequency was determined to be sufficient to readily detect any future leaks in a timely manner.

Q.46. Do you agree with Mr. Gundersen's assertion, at pages 6, 9, 10, 12, 15, and 21 of his testimony that the Unit 2 SFP "is apparently still actively leaking," based on his reference to a

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because boric acid does not evaporate from the pool; since water losses are made up by the addition of water to the pool, the concentration of boric acid remains relatively constant. Accordingly, any loss in boric acid concentration would be due to non-evaporative fuel pool losses, such as through spent fuel pool leaks and spent fuel pool cooling pump leaks.

SFP leak identified in 2010?

A.46. (JPN) No. Mr. Gundersen appears to base these assertions on the light box leakage discussed in my response to Question 43 above. As I stated in my response to Question 44 above, the possibility of other leaks cannot be completely ruled out; nonetheless, there has not been any observed increase in tritium concentrations in the three groundwater monitoring wells surrounding the Unit 2 SFP since 2010, indicating that any leakage, if it is occurring, is not significant.

Q.47. Do you agree with Mr. Gundersen's assertion, at page 9 of his testimony that "the Unit 2 SFP leak-collection box installed in 2007 failed in 2010 to meet its intended design function to collect any radioactive leaks and prevent such contamination from entering the groundwater"?

A.47. (JDN) No. The Unit 2 SFP leak-collection box was installed in 2006 directly on the side of the South wall of the Unit 2 SFP that was exposed during excavation activities related to construction of a new Gantry crane in this area. Prior to refilling the excavated area, a collection box was installed so that any further leakage from the South wall would be contained and collected inside the Auxiliary Building. That is the design function of the collection box, and it continues to fulfill its intended design function. The leak collection box was not intended to prevent leakage, and was not intended to collect leakage from other areas.

Q.48. Do you agree with Mr. Gundersen's assertion, at pages 10-11 of his testimony, that "future leaks from the Unit 2 pool are increasingly likely since the pool is 35-years old and facing the typical bathtub curve issues that aging plants face with concrete and systems degradation"?

A.48. (JDN) No. As discussed in response to Question 18 above, the pin-hole leak that was discovered in one corner of the Unit 2 SFP transfer canal was evaluated by a Non-Destructive Examination ("NDE") Level 3 expert and was determined to be an original welding imperfection. Further, the NDE expert evaluation of the pin-hole leak found that after 35 years of

service, the area of the pin-hole leak did not indicate any evidence of any type of degradation or corrosion. There is no evidence to support Mr. Gundersen's view that the SFP liner is degrading or would be likely to experience future leaks.

Q.49. Do you agree with Mr. Gundersen's assertion, at page 11 of his testimony, that "given the already degraded condition of the Unit 2 SFP, currently ongoing leaks, and Entergy's remarkably insufficient preventative measures, it is my opinion that leaks from the Unit 2 SFP are likely to continue"?

A.49. (JDN) No. As stated above, based on expert examination of the Unit 2 SFP transfer canal, no corrosion or degradation was found in the area of the pin-hole leak, and there has been no evidence that indicates any observable SFP liner degradation after 35 years of service. The history of problems involving the Unit 2 SFP consist of only two flaws: a pin-hole welding flaw from original fuel pool construction (repaired in 2007), and a fuel pool liner puncture accident caused by a welder in 1990, while welding new fuel pool rack brackets on the fuel pool wall (repaired in 1992). While onsite tritium levels remain above EPA municipal drinking water standards, the residual groundwater contamination levels have shown a decreasing trend, and should continue to decrease in the future. Further, Mr. Gundersen's reference to the maximum concentration levels (MCLs) in EPA's drinking water standards (at pages 20-21 of his testimony) is not appropriate, since there is no onsite drinking water use or drinking water source in the brackish Hudson River; therefore, the public and environmental impact of the current groundwater condition resulting from the Unit 2 SFP is negligible. Over the past several years, the residual groundwater contamination levels and environmental impacts have continued to decrease, reflecting the repairs that have been made.

Q.50. Mr. Gundersen states, at page 11 of his testimony, that:

> [The] NRC [Staff] has accepted Entergy's groundwater monitoring program with only one purpose in mind: according to NRC, this monitoring system is adequate for detecting conditions that have safety implications and which could result in a catastrophic meltdown in the event of an accident. In other words, the NRC has only

> evaluated this program in terms of whether or not the program will assure that the safety function of the spent fuel pools will be maintained and not result in a "loss of intended function" of the SFP.

Do you agree with that assertion?

A.50. No. Mr. Gundersen's statement is based entirely upon his citation and misreading of the Staff's Safety Evaluation Report ("SER"), Section 3.0.3.2.15 ("Structures Monitoring Program"), in which the aging management program for structures, including the spent fuel pools, is addressed.[18] Consistent with NRC practice, the SER addresses the safety implications of license renewal; in contrast, the environmental impacts of license renewal (including the radiological impacts of the SFP leaks) are addressed in the FSEIS, which Mr. Gundersen does not address in this opinion statement. In fact, our review of Mr. Gundersen's testimony indicates that he altogether fails to mention the FSEIS, other than to say that he has "reviewed" portions of the DSEIS and FSEIS that relate to spent fuel pool leaks and groundwater contamination (Gundersen Testimony, at pages 4-5).

Q.51. Do you agree with Mr. Gundersen's assertion, at page 12 of his testimony, that Entergy's monitoring wells "are not necessarily conducive to being able to rapidly respond to and repair leak issues," and that "residual contamination" from Unit 1 structures "will continue to periodically release to the groundwater, until the entire Indian Point site is decommissioned"?

A.51. (JDN) No. Based on the NRC Staff's inspections, current onsite groundwater monitoring wells have shown decreasing trends from earlier spent fuel pool leaks, and any other emergent leaks are now identified earlier due to implementation of the Long Term Ground Water Monitoring Plan. Over the past three years, monitoring of the groundwater has led to the prompt investigation and repair of one leaking component; further, compliance with the NEI Groundwater Protection Initiative will require prompt reporting of any identified new leak, which will allow NRC inspection follow-up to verify that sufficient corrective actions are taken to remediate the condition. This overall program will allow Entergy to minimize any new source of subsurface

[18] Gundersen Testimony at 11, n.21, citing SER at 3-139.

contamination, and will allow for continued decreasing natural attenuation of these leaks. In addition, NRC inspection procedures routinely review groundwater monitoring well results and require documentation of any reported new groundwater contamination conditions. This provides additional NRC engagement to assure effective licensee actions for any future radiological leak. The timely identification and repair of underground leaking structures should minimize any contribution to the residual groundwater contamination and minimize any cumulative impacts -- that are now a fraction of NRC liquid effluent release limits.

While there may still be "residual contamination" in Unit 1 structures, Entergy's actions in draining the spent fuel pools and moving the spent fuel to dry storage dramatically reduced the potential for further contamination from Unit 1 structures into the groundwater. Any leakage from Unit 1 structures that may occur in the future should be significantly less than the contamination that has occurred to date and should be detected by the groundwater monitoring program.

Q.52. To what extent, if any, are your views affected by Mr. Gundersen's assertion, at page 19 of his testimony, that he has found no other "operating U.S. nuclear power plant . . . is leaking such excessive amounts of tritium and strontium contamination [as compared to Indian Point], into any major body of water like the Hudson River"?

A.52. Our views are not affected by Mr. Gundersen's statement. The NRC recognizes that certain nuclear power plants, including Indian Point, have experienced leaks of radioactive materials into groundwater. A description of these leaks can be found, for example, in the NRC's 2006 "Liquid Radioactive Release Lessons Learned Task Force" report (Exhibit RIV000091); updated information on leaks and spills of radioactive materials at nuclear power plants is presented on the NRC's public website. The NRC has undertaken, through its inspection process, to assure that the licensees in each instance take appropriate actions for continued protection of public health and safety. This is the case at Indian Point. Further, as discussed in our testimony above, apart from tritium, the groundwater contamination at Indian Point (e.g., Sr-90) has been traced to leakage from the Unit 1 SFP, which has now been drained, resulting in

the effective termination of that source of contamination. Given the SFP repairs and groundwater monitoring program that have been put in place at Indian Point (discussed above), there is no reason to expect that any significant groundwater contamination will occur as a result of license renewal of Indian Point Units 2 and 3.

Q.53. Do you agree with Mr. Gundersen's assertion, at page 20 of his testimony, that the current Indian Point onsite groundwater concentrations are "high," insofar as they exceed the EPA's Maximum Contaminant Levels ("MCLs")?

A.53. No. The MCLs establish the EPA's standards for municipal drinking water supplies. It is inappropriate to use EPA drinking water standards to characterize onsite groundwater contamination levels, since there are no onsite drinking water sources at Indian Point. Further, the Hudson River at the plant location is brackish and not suitable for drinking, and releases into the river therefore should not be compared to the EPA's drinking water standards. In this regard, it should be noted that the EPA's MCLs for drinking water are for the "finished product", that is, the water coming from the tap to be consumed. Also, the concentration limit (e.g., the 20,000 pCi/L MCL value for tritium), represents the dose that would result if one were to drink two liters a day for a year; by EPA's calculations, drinking this amount of water with a tritium concentration of 20,000 pCi/L would result in an annual dose of 4 mrem. By comparison, a nuclear power plant's Technical Specifications limit the annual dose from radioactive effluents to the ALARA design objective of 3 mrem to the total body per reactor per year, as set out in Appendix I to 10 C.F.R. Part 50.

Further, the NRC requires the licensee for Indian Point to quantify all significant effluent discharges (including groundwater discharges) and to assess their impact to the public, based on site-specific characteristics, in order to determine the safety impact to the public and to assure compliance with NRC dose limits. Based on this appropriate comparison, releases at the Indian Point site continue to be less than 0.1% of the As Low As is Reasonably Achievable (ALARA) dose objectives established in 10 C.F.R. Part 50, Appendix I (3 mrem per year to the total body

and 10 mrem per year to the maximum organ).

Q.54. Do you agree with Mr. Gundersen's assertion, at pages 20-21 of his testimony, that "over time, the contamination spreads wider and deeper, . . . which may cast an inaccurate picture of the rate of overall decline," and that the "levels of radionuclides in the groundwater will likely remain high in the future"?

A.54. (JDN) No. Based on a detailed hydrogeologic investigation performed by Entergy and the NRC team of hydrogeology experts that reviewed that work, we determined that the onsite groundwater contamination has reached its maximum extent both horizontally and vertically, and that the termination of existing leaks and groundwater leaching of any residual contaminants through the ground has resulted in decreasing groundwater concentrations consistent with monitored natural attenuation. This is in addition to the natural process of radioactive decay, which will continue to reduce the levels of contaminants in the groundwater.

Q.55. Do you agree with Mr. Gundersen's assertion, at pages 22-23 of his testimony, that Sr-90 and Cs-137 present in the groundwater at Indian Point will contaminate the environment for centuries?

A.55. (JDN) No. First, with respect to the Sr-90 ground water contamination found at Indian Point, the Sr-90 concentration should decrease, with radioactive decay alone, to below the EPA drinking water limit for municipal water supplies (8 pCi/L) in approximately 50 years – wholly apart from the attenuation that will occur through groundwater migration to the river. Second, there is no detectable Cs-137 in riverside monitoring wells, and Cs-137 is therefore not being released to the river via the groundwater pathway. Finally, at the end of licensed activities and the decommissioning period, the site will be required to meet the NRC's criterion for unrestricted use of the property, of $\leq$ 25 mrem per year.

Q.56. Mr. Gundersen asserts, at page 23 of his testimony, that both fish and shellfish taken from the Hudson River during the 1970's and 1980's showed detectable levels of Sr-90 and Sr-89, and that the Sr-89 is a shorter-lived isotope that did not result from nuclear weapons

testing. Does this assertion affect your views?

A.56. (JDN) No. This statement, even if correct, does not point to the source of the Strontium found in the 1970's and 1980's. There has not been any detectable Sr-89 in any of Entergy's groundwater monitoring program samples. Since 2006, when contaminated groundwater was detected containing Sr-90, fish sample testing was modified to include Sr-90 analysis. To discriminate between nuclear weapons testing Sr-90 background from Sr-90 releases at Indian Point, in June 2007 an expanded fish sampling study was conducted by the NYSDEC, the NRC Staff and Entergy, to measure background levels of Sr-90 in Hudson River fish. Fish samples were taken from the impacted area at Indian Point, from the radioactive environmental monitoring program (REMP) control location 20 miles upstream of the plant, and from a fully segregated fish population location 90 miles upstream of the plant. Independent results obtained by all three participating laboratories determined that similar levels of Sr-90 were obtained from all three River locations, that the sample data provided a range of background Sr-90 levels that were due to nuclear weapons testing, and that the data could be used for future discrimination of Indian Point impacts for this radionuclide. Exhibit RIV000067, at page 7.

Q.57. Do you agree with Mr. Gundersen's suggestion, at page 24 of his testimony, that groundwater contamination at the Indian Point site should be evaluated based upon the "BEIR VII" report?

A.57. No. The BEIR VII report, issued in June 2005 by the National Academy of Sciences, reaffirms the linear-no-threshold theory and provides updated cancer risks due to ionizing radiation. The NRC and EPA set federal radiation protection dose limits based on their consideration of various scientific reports promulgated by such organizations as the International Commission on Radiological Protection ("ICRP"), the National Council on Radiation Protection and Measurements ("NCRP"), the United Nations Scientific Committee on the Effects of Atomic Radiation ("UNSCEAR"), the National Research Council Committee on the Biological Effects of Ionizing Radiation ("BEIR"), and other international consensus standards promulgated by the

ICRP, to provide the basis for federal regulations. While the BEIR VII report is informative, it does not establish regulatory limits. Rather, NRC licensees are required to comply with the regulatory limits set forth in 10 C.F.R. Parts 20 and 50, as discussed above.

Q.58. Do you agree with Mr. Gundersen's assertion, at page 24 of his testimony, that the NYSDEC fish tissue sampling study appears unreliable, because it "fails to note that other possible upstream sources of Strontium-90, especially the Knolls Atomic Power Lab (KAPL), may have affected the NYSDEC's assessment," and the study "appears to have been a one-time investigation"?

A.58. (JPN) No. The NYSDEC selected the upstream site following careful consideration. Significantly, the Hudson River fish sampling program (conducted in June 2007, not 2009 as stated by Mr. Gundersen) provided results from three different locations and the comparison of three different radiochemical laboratory analyses. Mr. Gundersen's statement regarding the Knolls facility is entirely speculative: If operation of the Knolls facility (or any other facility) resulted in radionuclide tissue sample data that significantly differ from the data collected at the other locations, that effect would be visible in the study's results. No such effect has been seen. The licensee has added Sr-90 to the testing regime for all future fish samples in its Radiological Environmental Monitoring Program and will continue to test for Sr-90 samples above background levels that have now been established by the NRC Staff and NYSDEC.

Q.59. Do you agree with Mr. Gundersen's assertion, at page 24 of his testimony that "Entergy and [the] NRC [Staff] fail to acknowledge other potential impacts that radioactive releases to the Hudson River may have upon the health of residents in proximity to the Hudson River," such as an increased incidence of cancer due to "recreational activities, such as swimming"?

A.59. (JDN) No. The potential use of the Hudson River for recreational and other activities was considered by Entergy and found not to be a significant pathway, as discussed in response to Question 25 above. There has been only occasional, very low detectable tritium (up

to or about 500 pCi/L) in Indian Point-related radioactivity measurable in the discharge canal. Accordingly, liquid effluent releases, including groundwater discharge, do not result in a meaningful external exposure pathway due to radionuclides in the river, even if use of the Hudson River were to include recreational activities such as swimming.

Q.60. Do you agree with Mr. Gundersen's assertion, at page 25 of his testimony, that radioactive contamination at Indian Point "will persist in the groundwater, likely at high levels, and be released to the Hudson River for decades," and that this renders invalid Entergy's strategy of "monitored natural attenuation"?

A.60. (JDN) No. Entergy has committed to implement its Long Term Ground Water Monitoring Program. Based on implementing this program, which will be regularly inspected by the NRC, the licensee will be able to detect new subsurface leaks, identify the leaking structure, and effectuate its repair in accordance with its corrective action program process. There is no evidence that groundwater contamination at the site will grow over time; rather, the evidence indicates that groundwater concentrations at the site are decreasing. As discussed in response to Question 23 above, GZA provided an evaluation of remediation options and concluded that pumping down the groundwater beneath the Unit 2 SFP would not be desirable, and monitored natural attenuation would be the most effective option. As also discussed in response to Question 23, the NRC Region I inspection team agreed with this conclusion, as discussed in the Staff's Inspection Report of October 19, 2009 (Exhibit ENT000343), and found that the program would be effective in detecting any future leaks to groundwater, so as to limit the discharge of radioactive materials at the site.

Q.61. Do you agree with Mr. Gundersen's assertion, at pages 25 and 28 of his testimony, that "[r]emediation of the radiological contamination via extraction wells is a far superior approach," "would clean the site much faster and more thoroughly than allowing the groundwater to flush radiological contamination directly into the Hudson River," and is therefore "preferable" to Entergy's strategy of monitored natural attenuation?

A.61(a). (JDN) No. As discussed in response to Question 23 above, the possible use of extraction wells to mitigate the groundwater contamination was considered by Entergy and the NRC Region I inspection team, and was determined to provide a less acceptable mitigation strategy than monitored natural attenuation due to the risks involved.

In this regard, a large capacity recovery well was installed in the Unit 2 Fuel Service Building truck bay, to provide a mitigation capability in the event of a future major incident involving a large leak from the Unit 2 SFP. A pump test was conducted to determine the effect of this well on the Unit 1 SFP Sr-90 plume. It was then determined that at a minimum very low pumping rate of 4 gallons per minute, the pumping caused a significant cone of groundwater depression, drawing Sr-90 from the Unit 1 contaminated area toward the Unit 2 area of the plant, which would result in spreading the Sr-90 contamination to larger areas of the plant and significantly increasing the scope of future decommissioning of the facility. Therefore, it was determined that unless a much more hazardous condition were to occur, extracting groundwater from this well would not be warranted.

Further, monitored natural attenuation is an accepted remediation technique, provided the leak is terminated and the hazard level to the public is minimal. Public radiation dose impact calculations inform us that the monitored levels of radioactive releases from groundwater at Indian Point represent a very small fraction of EPA and NRC public exposure limits, and therefore, the hazard level to the public is minimal. Entergy's selection of the monitored natural attenuation remediation option is therefore appropriate.

A.61(b). (SPK) I agree with Mr. Noggle's testimony in Answer 61(a) above, and with the NRC inspection team's conclusion that immediate remediation using the extraction method is not preferable to Entergy's strategy of monitored natural attenuation. Strontium-90 migrates slowly through the ground and, if left in place, will present less of a problem as it undergoes radioactive decay over time. Further, Entergy would have to dispose of the tritium that it extracts from the groundwater, possibly through planned releases to the river, within the ALARA design

objectives; this could result in potentially greater concentrations and environmental impacts than would occur through gradual, monitored natural attenuation.

Q.62. Dr. Stewart, at pages 2, 3, 4, 6, and 7 of her testimony, points to a possible use of the Hudson River for drinking water if a desalination facility is designed, built and permitted in Haverstraw Bay, and asserts that this potential development has not been adequately considered by Entergy and the NRC Staff. Do you agree with her views concerning this matter?

A.62. (SPK) No. The Final SEIS considered the potential development of the "Haverstraw Long-Term Water Supply Project." In Appendix A of the FSEIS, on page A-95, the Staff responded to comments about the potential development of this water desalination plant downstream of the Indian Point plant site. The Staff addressed this issue as follows:

> Regarding the potential operation of a Rockland County desalination plant, the NRC staff addressed potential future cumulative radiological impacts in Chapter 4, section 4.8.3, "Cumulative Radiological Impacts." The NRC staff discussed the applicable radiation protection limits set by the NRC and the EPA to protect members of the public from the cumulative impacts of radiation. The NRC staff noted that the NRC and the State of New York would regulate any future actions in the vicinity of IP2 and IP3 that could contribute to cumulative radiological impacts. Therefore, <u>if plans for the proposed Rockland County desalination plant advance to the licensing phase, the facility would be required to have the means to monitor the source water and, if necessary, have a treatment system to meet applicable drinking water standards for radioactivity and nonradioactive contaminants</u>."

Exhibit NYS000133D, at A-95; emphasis added.

In January 2012, NYSDEC posted information on its website related to the proposed "Haverstraw Long-Term Water Supply Project." There, NYSDEC indicated that it would serve as lead agency for this project, and is responsible for applicable permitting:

> The Department is serving as the Lead Agency for the environmental review of the project pursuant to SEQR. The Department's permit authority for the project includes: a SPDES permit for the discharge of the treated wastewater; a Water Supply permit for development of a new water supply source; an Excavation & Fill permit for the installation of the intake structure; and a Water Quality Certificate for the installation the intake structure and for the potential impact to federal wetlands in the upland portions of the project.

On January 18, 2012, the Department issued a Combined Notice of Complete Application and Notice of Acceptance of the Draft Environmental Impact Statement, Public Hearing and Public Comment Period.

The potential construction and permitting of the Haverstraw water supply project does not alter the Staff's evaluation of this project in the FSEIS for Indian Point. As the Staff stated in its FSEIS, "if plans for the proposed Rockland County desalination plant advance to the licensing phase, the facility would be required to have the means to monitor the source water and, if necessary, have a treatment system to meet applicable drinking water standards for radioactivity and nonradioactive contaminants." The information posted by the New York State Department of Environmental Conservation shows the Staff's position to be correct.

In sum, the license renewal of Indian Point Units 2 and 3 is not expected to affect the Haverstraw project, in that the facility would be sited on the opposite side of the Hudson River, and Entergy's radiological environmental monitoring program shows that liquid effluent releases from Indian Point, including groundwater discharges, do not result in detectable levels of tritium or other radionuclides in the Hudson River that would impact the EPA's drinking water standards. Further, the proposed facility will be required to meet NYSDEC's permit requirements and the EPA's drinking water standards, thus assuring public safety.

Q.63. Do you agree with Dr. Stewart's views, expressed at pages 3-5 of her testimony, regarding the environmental impacts of Sr-90 and Cs-137 in the groundwater at Indian Point or the Hudson River?

A.63. (JDN) No. Dr. Stewart introduced her comments regarding these radioisotopes with a hypothetical statement, saying that health impacts could occur "<u>If</u> there is present, past, or future leakage of radio-activity in the form of Sr-90, H-3, Cs-137 or other isotopes from Indian Point into the waterway of the Hudson River . . . ." Stewart Testimony at 3. Dr. Stewart fails to mention that the detectable Sr-90 radioactivity in the river has been found to be nuclear weapons

testing background radiation, and not related to Indian Point. Further, as stated in my response to Question 55 above, while some Cs-137 has been detected due to atmospheric weapons testing, water samples do not show the presence of any Cs-137 releases from Indian Point. Dr. Stewart's comments about these radioisotopes are therefore not applicable.

Q.64. Does this conclude your testimony?

A.64. Yes.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket Nos. 50-247-LR/ 50-286-LR
	)	
(Indian Point Nuclear Generating Units 2 and 3)	)	

AFFIDAVIT OF STEPHEN P. KLEMENTOWICZ
CONCERNING CONTENTION
RIVERKEEPER EC-3/CLEARWATER EC-1 (SPENT FUEL POOL LEAKS)

I, Stephen P. Klementowicz, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 C.F.R. § 2.304(d).

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March 30, 2012

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BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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AFFIDAVIT OF JAMES D. NOGGLE
CONCERNING CONTENTION
RIVERKEEPER EC-3/CLEARWATER EC-1 (SPENT FUEL POOL LEAKS)

I, James D. Noggle, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 C.F.R. § 2.304(d).

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September 21, 2012