March 16, 2006

Mr. Fred R. Dacimo
Site Vice President
Entergy Nuclear Operations, Inc.
Indian Point Energy Center
295 Broadway, Suite 1
P.O. Box 249
Buchanan, NY 10511-0249

SUBJECT: INDIAN POINT NUCLEAR GENERATING UNIT 2 - NRC SPECIAL INSPECTION REPORT NO. 05000247/2005011

Dear Mr. Dacimo:

On February 28, 2006, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at the Indian Point Nuclear Generating Unit 2 (IP2). The enclosed inspection report documents the inspection findings, which were discussed on February 28, 2006, with Mr. Jim Comiotes and other members of your staff.

The purpose of this special inspection, initiated on September 20, 2005, was to assess issues related to Entergy's discovery of a small amount of contaminated water leaking from the Unit 2 spent fuel pool, and the subsequent discovery of subsurface groundwater contamination in a monitoring well located in the IP2 transformer yard. This inspection focused on Entergy's initial efforts to explore and evaluate the extent of contamination, as well as to determine the source(s) of the groundwater contamination. At the completion of our inspection on February 28, 2006, Entergy was still involved in groundwater exploration and assessment and had completed installation of the first phase of monitoring wells. These efforts have resulted in a degree of understanding with respect to the groundwater transport of the radioactive contaminants and associated dose calculations for potential exposure to the public. Entergy and your contractors are proceeding with further evaluations and are installing additional onsite monitoring wells. A followup NRC report will be issued providing the final conclusions with respect to Entergy's actions to control, mitigate, and remediate (as necessary) the onsite groundwater contamination. Continued NRC inspection of your activities was approved by the NRC's Executive Director for Operation as described in our October 2005 Reactor Oversight Process Deviation Memorandum.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations, and with the conditions of your license. Within these areas, the inspection consisted of a selected examination of procedures and representative records, observations of activities, interviews with personnel, and independent analyses of water samples.

The team found Entergy's response to identified conditions to be reasonable and technically sound. The existence of onsite groundwater contamination, as well as the underlying source(s) of leakage, are conditions warranting continued efforts by your company to resolve them, yet they do not present significant risk to public health and safety or to the environment. 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 onsite conditions is negligible with respect to conservatively established NRC regulatory limits.

Our inspection activities thus far have not identified any significant licensee performance deficiencies. However, please note that this report, while reaching important safety conclusions, does not provide our final regulatory or enforcement conclusions. These conclusions will be provided in a follow up inspection after your ongoing work, outlined above and detailed in the enclosed report, has yielded additional information for NRC review.

The enclosed inspection identifies areas for enhancement regarding the focus of your program under a 1980 NRC Bulletin related to contamination of normally nonradioactive systems, as well as some details of how your corrective action tools were employed in your followup of the fuel pool wall seepage and groundwater sample results. We deemed these observations to be of minor safety significance, but have included them in Sections 7 and 8 of our report for your use in continued efforts to improve your programs.

As you know, NRC is reviewing generic implications of recent discoveries of groundwater contamination at several plants; and the NRC review will include both industry aspects and NRC regulatory learnings. Notwithstanding, NRC inspection results will vary plant-to-plant based on the facts of each case.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of the NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). Further, in light of ongoing public interest in these matters, the NRC has scheduled a public meeting in Peekskill, New York on March 28, 2006, as announced by our Meeting Notice dated March 10, 2006, also available at the NRC web site at http://www.nrc.gov/reactors.plant-specific-items/Indian-point-issues.html.

Sincerely,

/RA/

A. Randolph Blough, Director
Division of Reactor Safety

Docket No. 50-247
License No. DPR-26

Enclosure: Inspection Report No. 05000247/2005011
w/Attachment: Supplemental Information
cc w/encl:
G. J. Taylor, Chief Executive Officer, Entergy Operations, Inc.

M. R. Kansler, President - Entergy Nuclear Operations, Inc.
J. T. Herron, Senior Vice President and Chief Operating Officer
P. Rubin, General Manager - Plant Operations
O. Limpias, Vice President, Engineering
C. Schwarz, Vice President, Operations Support
J. McCann, Director, Licensing
C. D. Faison, Manager, Licensing, Entergy Nuclear Operations, Inc.
P. Conroy, Manager, Licensing, Entergy Nuclear Operations, Inc.
M. Colomb, Director of Oversight, Entergy Nuclear Operations, Inc.
J. Comiotes, Director, Nuclear Safety Assurance
T. C. McCullough, Assistant General Counsel, Entergy Nuclear Operations, Inc.
P. R. Smith, President, New York State Energy, Research and Development Authority
J. Spath, Program Director, New York State Energy Research and Development Authority
P. Eddy, Electric Division, New York State Department of Public Service
C. Donaldson, Esquire, Assistant Attorney General, New York Department of Law
D. O'Neill, Mayor, Village of Buchanan
J. G. Testa, Mayor, City of Peekskill
R. Albanese, Executive Chair, Four County Nuclear Safety Committee
S. Lousteau, Treasury Department, Entergy Services, Inc.
Chairman, Standing Committee on Energy, NYS Assembly
Chairman, Standing Committee on Environmental Conservation, NYS Assembly
Chairman, Committee on Corporations, Authorities, and Commissions
M. Slobodien, Director, Emergency Planning
B. Brandenburg, Assistant General Counsel
Assemblywoman Sandra Galef, NYS Assembly
County Clerk, Westchester County Legislature
A. Spano, Westchester County Executive
R. Bondi, Putnam County Executive
C. Vanderhoef, Rockland County Executive
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T. Judson, Central NY Citizens Awareness Network
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Public Citizen's Critical Mass Energy Project
M. Mariotte, Nuclear Information & Resources Service
F. Zalcman, Pace Law School, Energy Project
L. Puglisi, Supervisor, Town of Cortlandt
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Congresswoman Nita Lowey
Senator Hillary Rodham Clinton
Senator Charles Schumer
J. Riccio, Greenpeace
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cc w/encl (Continued)
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U.S. NUCLEAR REGULATORY COMMISSION

REGION I

Docket No.	50-247
License No.	DPR-26
Report No.	05000247/2005011
Licensee:	Entergy Nuclear Northeast
Facility:	Indian Point Nuclear Generating Station Unit 2
Location:	295 Broadway Buchanan, NY 10511-0308
Dates:	September 13, 2005 - February 28, 2006
Inspectors:	J. Noggle, Sr. Health Physicist, CHP, Team Leader R. Codell, Sr. Hydraulic Engineer, PhD S. Chaudary, Civil Structural Engineer J. Kottan, Sr. Health Physicist M. Cox, Senior Resident Inspector, IP2 C. Long, Acting Resident Inspector, IP2 T. Nicholson, Sr. Technical Advisor for Radionuclide Transport
Approved by:	John R. White, Chief Plant Support Branch 2 Division of Reactor Safety

Enclosure

TABLE OF CONTENTS

SUMMARY OF FINDINGS

IR 05000247/2005011; 09/13/2005 - 02/28/2006; Indian Point Nuclear Generating Station Unit 2.

The report covers a special inspection of a September 1, 2005, licensee-identified Unit 2 spent fuel pool leak by three regional inspectors, two headquarters specialists, and two resident inspectors. No significant findings were identified. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. NRC Identified and Self-Revealing Findings

Cornerstone: Public Radiation Safety

No significant findings were identified.

EXECUTIVE SUMMARY

The inspection determined that public health and safety has not been adversely affected and the dose consequence to the public that can be attributed to current onsite conditions is negligible with respect to NRC regulatory limits. Notwithstanding the completion of this inspection, NRC will continue to inspect and review Entergy's efforts to resolve the conditions that resulted in the contamination of groundwater as described in an NRC memorandum dated October 28, 2005, "Request for Deviation from the Reactor Oversight Process Action Matrix to Provide Increased NRC Oversight to Specific Issues at Indian Point Energy Center" (ML053010404).

The results are further summarized in later paragraphs of this Executive Summary.

Background

In August 2005, Entergy was excavating in the Unit 2 Fuel Storage Building (FSB) Loading Bay, adjacent to the south wall of the Spent Fuel Pool (SFP), in preparation for installation of a gantry crane required to support the Independent Spent Fuel Storage Installation Project. While removing material along the south wall of the SFP, two cracks (about 1/64" wide) were observed that exhibited moisture. Analyses of the moisture indicated that the material had the same radiological and chemical characteristics as SFP water. The primary radioactive constituent was identified as tritium.

Upon assessment of the condition, NRC initiated a Special Inspection in accordance with a "Special Inspection Charter-Indian Point Unit No. 2" (ML05264003), dated September 20, 2005, to better understand the source of the radiological contamination, the cause, the extent of condition, any potential impact on spent fuel pool integrity, and to confirm that public health and safety was being maintained as required by the regulatory requirements.

On September 29, 2005, Entergy sampled water from MW-111 (an existing well installed in the Unit 2 Transformer Yard, which was last analyzed for tritium in 2000, with no tritium detected). However, analysis of the September 2005 sample, reported on October 5, 2005, indicated unexpected concentration of tritium in onsite groundwater. Accordingly, Entergy expanded its investigation to encompass not only the Unit 2 SFP condition, but also the extent of onsite groundwater contamination revealed by the MW-111 sample. Also, NRC "Special Inspection Charter-Indian Point Unit No. 2 (Updated)" (ML052800395), dated October 7, 2005, expanded the scope of the NRC Special Inspection.

As Entergy continued investigation into the source of the contamination, hydrological information and sample analyses of various monitoring wells led to the conclusion that some contaminated groundwater likely will, or has migrated to, the Hudson River which is considered an abnormal release via a pathway other than the engineered pathways for plant effluents. While hydrological site assessment and groundwater analysis allow conservative estimation of such a release to confirm that public health and safety is not adversely affected, continued efforts are necessary by Entergy to find the source(s), repair the condition, and restore the effluent control process as originally designed.

Special Inspection Results

The Special Inspection accomplished the following objectives:

- Development of a time line of events leading up to the present condition.

  See Attachment 1, as well as additional details throughout the report.

- Assessment of the Unit 2 Spent Fuel Pool integrity.

  Assessment of pertinent information, data, and analysis of the observed leakage of water on the south wall of the spent fuel pool supports the licensee's conclusion that the condition is not expected to result in any reduction in integrity of the spent fuel pool structure.

- Review of SFP inspection activities conducted to determine the presence of potential leakage from accessible portions of the SFP liner.

  Accessible areas of the Spent Fuel Pool (approximately 40% of SFP liner) have been inspected. Six areas of interest have been examined and tested. To-date, no leaks have been identified. Entergy is exploring methods and techniques to allow examination of the remaining areas.

- Radiological Assessment of the onsite conditions associated with potential SFP leakage and groundwater contamination, including review of Entergy's bounding analysis.

  The original bounding calculation based on Unit 2 SFP inventory loss calculation of 2.6 gpd of SFP water inventory released directly into the Hudson River, resulted in a dose estimate to the public of 1E-4 mrem/year, to the maximally exposed individual. A more refined calculation based on actual measurements from the Phase 1 monitoring wells, survey analyses, annual rainfall recharge to groundwater, information determined from current hydrological assessment, and application of an estimated hydrological gradient to the Hudson River, indicates a total body dose of 1.5E-5 mrem/year, to the maximally exposed individual. This represents 0.00005% of the 3 mrem/year limit for liquid effluent releases. For perspective, the average radiation exposure from natural sources to an individual in the United States is 300 mrem/year. In addition, man-made sources, such as medical procedures, contribute another 60 mrem, for a total of 360 mrem/year.

- Independent sampling and analyses of onsite and offsite groundwater sampling locations, (i.e., Entergy, New York State Department of Environmental Conservation (NYS DEC), and NRC continue to split and inter-compare onsite and offsite groundwater and surface water samples).

  Several initial and periodic liquid samples were split between the licensee, the NRC and the NYS DEC. These samples were measured and analyzed for radioactivity by each of their respective radiochemical laboratories. Where common samples were analyzed and detectable activity was measured, the

results were found to be in good agreement.

Additionally, a sample of MW-111 by the NYS DEC, taken on October 21, 2005, and reported in February 2006, indicated 3 pCi/l, Sr-90, (i.e., the lower limit of detection was about 2 pCi/l; and the EPA drinking water standard is 8 pCi/l). Previous samples of the same well taken by NRC and Entergy did not detect Sr-90. A split sample of MW-111 had been taken on February 7, 2006, by Entergy, NYS DEC and NRC and may help to determine whether Sr-90 is present. All other onsite radiological measurements of groundwater had not identified any other plant-related activity except for tritium. Results of MW-111 were expected in March 2006. No plant-related radioactivity was identified in any offsite sample of surface or groundwater sources.

- On-going review of Entergy's preliminary geological-hydrological assessment and groundwater characterization efforts through the completion of the licensee's Phase I monitoring well system.

  Entergy has completed an initial set of monitoring wells (Phase 1) to assess and characterize groundwater movement and behavior relative to groundwater contamination in the vicinity of Unit 2. Full site characterization efforts are continuing. Preliminary results indicate that tritium contaminated groundwater underlays the Unit 2 transformer yard area. Entergy recently completed and sampled water from two wells (MW-36 and MW-37), that were positioned to determine if contaminated groundwater under the Unit 2 transformer yard may be migrating to the Hudson River under the discharge canal. Tritium was detected in both of these wells. Based on these results and its preliminary hydrological characterization of the site, Entergy concluded that some contaminated groundwater likely will or has migrated to the Hudson River. The company's radiological assessment, outlined earlier in this Executive Summary, encompassed such a migration.

- Review and assessment of Entergy's onsite radioactive sampling program of nonradioactive systems, specific to storm drainage systems.

  The inspection looked at prior indications of tritium leaks onsite. Sample data from previous efforts to examine such non-radioactively contaminated systems such as storm drains were reviewed. To-date, the inspectors have found no circumstance that could reasonably be viewed as a failure of Entergy to follow standards or take measures that would have prevented the current onsite conditions; or react to circumstances and conditions that would have led to earlier detection.

- Review and assessment of Entergy's effluent controls affecting the Unit 1 spent fuel pool system leakage and associated groundwater collection system.

  The inspection investigated the collection efficiency of the Unit 1 groundwater collection system. A tritium mass balance study indicated that the Unit 1 ground-water collection system likely is collecting more tritium than may be

associated with estimated leakage rate from the Unit 1 spent fuel pool systems. Notwithstanding, current information and assessment continue to indicate that the Unit 1 groundwater and leakage collection systems are effectively collecting and monitoring groundwater and leakage, and discharging the effluent to the discharge canal. All tritium activity from the collection system, regardless of the source, is monitored and documented as an effluent release in accordance with NRC regulatory requirements. The Unit I spent fuel pool leakage collection system is an area that has been subject to previous NRC inspection.

- Review and assessment of Entergy's corrective action program.

  The inspectors reviewed the conditions and circumstances associated with a previously identified leak of the Unit 2 spent fuel pool (SFP) in 1992, including the effectiveness of the licensee's corrective actions following that event. The inspectors confirmed that the licensee's corrective actions for that earlier leak were reasonable for the circumstances; and did not find a connection between that event and the current onsite conditions. The inspectors confirmed that the licensee is adequately following its corrective action process relative to the current onsite conditions, including conditions affecting the Unit 2 spent fuel pool. The licensee is continuing efforts to establish the current source(s) of leakage.

  The team sought to evaluate whether there were reasonable earlier opportunities for the licensee to identify the leakage into onsite groundwater and to intervene to prevent or mitigate an abnormal release of radioactivity. The team did not find such an opportunity for Entergy to identify the current SFP wall leakage before the excavation next to that wall. However, the ongoing site characterization activities suggest that other sources of leakage could exist. If other sources are found, NRC followup inspections will revisit the question as to whether earlier recognition was possible.

- Review and assessment of applicable rules and regulatory requirements pertinent to existing onsite conditions.

  The current identified groundwater release has been classified by the licensee as an abnormal release, as specified in Regulatory Guide 1.21, and will be included in the 2005 effluent release report as required. The current radioactivity releases and associated public doses are below the NRC radioactivity release and public dose limits. Although this inspection examined a number of aspects of regulatory compliance as detailed in Section 9 of the report, final regulatory conclusions await a followup inspection after ongoing licensee activities have yielded additional information for NRC review.

- Identification of generic aspects.

  Contamination of onsite groundwater due to leaking plant structures, systems or components is being reviewed by the NRC as a potential generic issue. The NRC generic review will examine not only industry implications, but also NRC regulatory learnings. The NRC Team Leader and other NRC Region Health

Physics specialists closely communicated with NRC Headquarters throughout the inspections, and will continue to do so, as NRC formulates its generic reviews and associated industry communications.

Public Health and Safety Conclusion

Based on currently available information and the sampling data that have been analyzed and assessed to date, NRC has not found any condition that indicates that occupational or public health and safety have been, or likely will be, affected by the current onsite groundwater contamination. This assessment is based on the fact that there is no drinking water pathway associated with groundwater or the Hudson River in the region surrounding Indian Point Energy Center, and samples taken in support of the NRC-required Radiological Environmental Monitoring Program (REMP) continue to indicate no detectable plant-related radioactivity in groundwater beyond the site boundary. Samples taken include the offsite REMP sampling locations, the local municipal drinking water reservoirs, and other groundwater monitoring wells located in the immediate vicinity of the plant.

Report Details

Description and Chronology of Events

On September 1, 2005, a hairline crack (about 1/64" in width, about 7 feet in length, was found at approximately the 65 foot elevation of the Unit 2 spent fuel pool south wall (approximately 30 feet below the top) during excavation of the spent fuel building loading bay. The crack was initially only a moist indication. During the next two weeks, as excavation continued, a second crack was discovered at the 60 foot elevation and a temporary collection device was installed to capture any leaking liquid. These cracks had the same characteristics as the small fissures typically observed in large pours of concrete upon curing.

The crack weeping gradually increased following the first measurable liquid sample of 12 ml collected on September 13, 2005. Radiological analysis of this water sample confirmed tritium and boron content consistent with the Unit 2 spent fuel pool. During the next several weeks, the cracks exhibited increased leakage to a maximum of between 1-2 liters per day. This rate of leakage remained stable, then declined to minimal by late December 2005.

An initial onsite NRC structural engineering assessment of the cracks occurred on September 8-9, 2005, and an initial onsite NRC radiological assessment was conducted on September 13-15, 2005. The NRC initiated a Special Inspection Team (SIT) in accordance with the Special Inspection Charter dated September 21, 2005, to investigate the structural and radiological implications of the observed Unit 2 spent fuel pool leakage, and assess the licensee's corrective measures, radiological evaluation, and investigative actions.

As part of this effort, Entergy sampled existing "Due Diligence" wells that were developed in 2000. One of these wells, MW-111 (last sampled for tritium in 2000 with no activity detected) was sampled on September 29, 2005. The analytical result, reported on October 5, 2005, indicated 211,000 pCi/l, tritium. Accordingly, the Special Inspection Charter was revised on October 7, 2005, to include a review and assessment of licensee's actions relative to the contaminated groundwater indicated by this sample result. A detailed sequence of events is provided in Attachment 1.

1. ~~Structural Integrity of the Unit 2 Spent Fuel Pool~~

   a. Inspection Scope

      The inspector reviewed and evaluated Entergy's assessment of the structural integrity of the Unit-2 Spent Fuel Pool (SFP) relative to observation of small hairline cracks on the south wall of the Spent Fuel Pool, as described in CR -IP2-2005-03557. The inspector visually examined the affected area and confirmed that the cracks appeared as shrinkage cracks that are normal to concrete curing during set-up. The inspector also reviewed documentation of the licensee's "Study of Potential Concrete Reinforcement Corrosion of the Structural Integrity of the Spent Fuel Pit." The inspector also reviewed the design parameters and specifications of the SFP, and historical and current structural analyses, including a structural integrity assessment performed in 1993, which also assessed seismic qualification. Entergy's plans and methods to examine the SFP liner for integrity were also reviewed. The SFP is a Class I structure as specified in the

Unit 2 Update Facility Safety Analysis Report.

b. Findings and Assessment

No safety significant findings were identified.

The SFP wall consists of 4 feet thick concrete, and is heavily reinforced with steel rebar. The inside of the SFP is lined with 1/4-inch stainless steel plate anchored to the concrete such that the plate and concrete are in contact, with only a small interstitial area between. The hairline concrete cracks, two of which were moist, were discovered in the south wall of the Unit 2 Spent Fuel Pool (SFP), at an elevation of approximately 60 feet and 65 feet. In order to meet seismic design requirements, the SFP is not supported by adjacent structures. The top of the SFP base slab is at an elevation of 54 feet 7 inches. The SFP has a horizontal construction joint at elevation 75 feet, and the top of the pool wall is at elevation of 95 feet. As observed by the inspector, the cracks were very narrow (less than 1/64-inch wide). Both cracks initially exhibited some moisture.

Since installing a gantry crane counterweight in the loading bay, the excavated area has been backfilled. However, in order to continue to monitor moisture that may emerge from the cracks, a moisture collection box was fabricated and installed over the affected area. The device drains into adjacent primary auxiliary building to provide a means to continuously monitor the condition of the wall and any emerging liquid.

The licensee analyzed and evaluated the potential for rebar corrosion and the SFP structural design using computer models and bounding calculations that were based on very conservative assumptions. Entergy's consultant performed an evaluation of the SFP cracks and documented its findings in ABS Consulting Report 1487203-R-001.

The inspector reviewed the licensee's analysis and confirmed that the applications and analytical methods used by Entergy were reasonable and appropriate, and correctly applied. Based on this effort, it was concluded that the leakage condition affecting the Indian Point 2 SFP structure would not adversely affect the integrity of the structure or its safety function.

2. ~~Unit 2 Spent Fuel Pool Radiological Assessment~~

a. Inspection Scope

The inspectors observed the Unit 2 Spent Fuel Pool (SFP) leakage in the south wall; and the installation of the licensee's system for collecting moisture from the affected area. The inspectors reviewed the analytical results of the water leakage from the Unit 2 SFP. Samples of the water were split between the licensee and the NRC for the purpose of inter-comparison. Results of analysis are contained in Attachment 3 to this report.

The inspectors also reviewed Entergy's assessment of the potential offsite dose consequences that may be associated with leakage from Unit 2 SFP leak. Onsite well water samples were also split between the licensee, the State of New York, and the NRC. These samples were taken from wells that were installed since October 2005 to

characterize groundwater behavior and monitor the extent of groundwater contamination. The NRC samples were sent to the NRC contract laboratory, the Oak Ridge Institute for Science and Education (ORISE), Environmental Site Survey and Assessment Program (ESSAP) radioanalytical laboratory.

b. Findings and Assessment

No significant findings were identified.

> [Note: The values of radioactive concentrations expressed in this report are generally reported as picoCuries per liter (i.e., pCi/l) to allow easy reference to the Federal Environmental Protection Agency regulation, 40 CFR 141 standards on drinking water. For example, the EPA limit of tritium concentration in drinking water is 20,000 pCi/l; and for strontium-90, 8 pCi/l. Though there is no drinking water pathway involving groundwater or the Hudson River in the region surrounding the Indian Point Energy Center, reference to these EPA values permits perspective. These values represent an annual effective total body dose of 4 mrem in the case of continuous consumption of water at these concentrations for a year. The average annual radiation exposure from natural sources to an individual in the United States is about 300 millirem.]

Entergy's measurements of radioactivity in various samples taken to ascertain the extent of groundwater contamination were of good quality and of sufficient sensitivity to assess radiological impact. The quality of Entergy's measurements were confirmed by various split samples analyzed by NRC and the State of New York, (Department of Environmental Conservation; and Department of Health).

The licensee's data indicated that the leakage from the Unit 2 SFP leak was on the order of one to two liters per day from September through November 2005 and declined to a minimal leakage rate to the present. The licensee's analytical data from the samples of the moisture indicated the presence of Co-60, Cs-134, Cs-137, H-3, Ni-63, and Sr-90. Sample results are reported in Attachment 3. Since the time that leakage from the Unit 2 SFP south wall was identified, all moisture has been collected by the licensee and disposed of as liquid radioactive waste. Currently, a leak collection device is attached to wall and is designed to continue collecting any emergent water from this location.

During the period of this inspection, the licensee also identified contamination in ground-water samples from an onsite well (MW 111). Tritium was measured in this well at a concentration of about 211,000 pCi/l. This is a factor of 10 greater than the EPA drinking water standard of 20,000 pCi/l. In response, the licensee initiated a ground-water monitoring program to identify the source of the contamination that was affecting onsite groundwater and the extent of the contamination. The groundwater monitoring program required the drilling of additional onsite wells in order to characterize the site hydrological conditions and monitor the extent of the contamination. Phase 1 of the groundwater monitoring program consisted of nine additional onsite wells which are

currently completed and operating. Phase 2, which requires about 14 additional wells, is in process; and the wells are expected to be completed by April 2006.

The licensee performed an initial bounding dose calculation, dated October 21, 2005, that assumed that water from the SFP was discharged into the Hudson River via ground water. This dose assessment assumed a conservative Unit 2 SFP leak rate of 2.6 gallons per day[1] incorporating all the radionuclides detected in the leak water, with a dilution flow of approximately 100,000 gpm. The resultant calculated dose was about 1E-4 millirem/year, well below the NRC-required dose limit of 3 millirem/year specified in the licensee's Offsite Dose Calculation Manual, for the maximally exposed individual.

The inspectors concluded that the licensee's preliminary offsite dose calculation applied the methodology of the licensee's Offsite Dose Calculation Manual, utilized conservative assumptions regarding the Unit 2 SFP leak rate, and resulted in a calculated dose that was a small percentage of the licensee's offsite dose limit.

As more data became available, the licensee performed a bounding calculation, dated December 13, 2005, using the river dilution available during a six hour half tidal cycle. This resulted in a dilution volume of 1.45E10 gallons. The resultant annual dose to the maximally exposed member of the public was calculate to be about 1E-4 millirem. Both of these calculations used the actual source term from the Unit-2 SFP relative to radioactivity. The exposure pathways considered fish and invertebrate consumption since there is no drinking water pathway that involves groundwater or the Hudson River in the region surrounding the Indian Point Energy Center.

Late in the inspection period, the licensee introduced a more refined assessment of to provide an interim site-wide dose calculation to account for various areas of the site where tritium had been detected. This approach divided the site into separate ground-water drainage areas and took into account actual measurements of tritium and ground-water behavior. Annual rainfall recharge into the areas was assumed to intercept the currently known areas of tritium contamination as represented by storm drain and monitoring well samples. This preliminary site-wide dose calculation indicated 1.5E-5 millirem/year, to the maximally exposed individual. This represents 0.00005% of the 3 mrem/year limit for liquid effluent releases. This approach was based on conservative assumptions of groundwater volume, flow rate, radioactive concentrations, and precipitation. Entergy expects to revise bounding dose calculations as additional data on groundwater flow and dilution are determined from the ongoing groundwater characterization efforts.

3. ~~Sample Results~~

Over the course of the inspection, hundreds of samples were taken by Entergy and reviewed by the NRC to assess the radiological conditions onsite and offsite. In an effort to verify the quality of analytical results, several samples were split between Entergy,

[1]The basis for the assumed value of 2.6 gallons per day is discussed in Section 4 of this report.

New York State, and the NRC to demonstrate consistency and comparability of the data. The analytical results of split samples are described in Attachments 2 through 5. The NRC's actual analytical results, as reported by NRC's contractor, Oak Ridge Institute for Science and Education (ORISE), Environmental Site Survey and Assessment Program (ESSAP), are available for public review at ADAMS Accession No. ML060720148.

Attachments 2 through 5 contain the NRC analytical results and the licensee's analytical results for the split samples. Also presented in Attachments 2 through 5 is the analytical sensitivity or minimum detectable concentration (MDC) for the measurement procedures for those samples in which radioactivity was considered not detected. Licensee results could only be compared to NRC results when measurable radioactivity was present in the sample. Comparisons were not made with analytical results provided by the State of New York. The purpose of the split samples was to assess the licensee's capability to accurately measure radioactivity in the split samples.

Confirmation of Licensee Sample Results

The inspectors reviewed the licensee's methods and procedures for tritium analysis. The licensee provided samples to several laboratories for analysis. Onsite samples for tritium and gamma isotopics were usually analyzed on site; radiological environmental samples taken offsite were sent to either Entergy's James A. FitzPatrick Nuclear Power Plant, Environmental Laboratory, or Teledyne Laboratories.

The inspectors reviewed laboratory procedures and processes to assure that acceptable protocols were applied. The application of distillation and filtering techniques were reviewed to assure that samples suspected of containing tritium were adequately prepared prior to analysis to separate the tritium from any other radionuclides that may be present in the sample.

During the course of the onsite ground contamination investigation, several initial and periodic liquid samples were split between the licensee, the NRC and the State of New York. These samples were measured and analyzed for radioactivity by each of their respective radiochemical laboratories. The NRC samples were sent to the NRC contract laboratory, ORISE/ESSAP radioanalytical laboratory. Comparable licensee and NRC sample results were tested for agreement utilizing the acceptance criteria contained in NRC Inspection Procedure 84750, "Radioactive Waste Treatment, and Effluent and Environmental Monitoring". Where common samples were analyzed and detectable activity was measured, the results were found to be in agreement except in one case involving a Unit 2 spent fuel pool leak sample as noted in Attachment 3. This disagreement was 2% outside the acceptance criteria and not considered significant. In addition, the licensee's result was higher than the NRC's result in this case. An additional confirmation of measurement accuracy was provided by New York State Department of Health Laboratory. The results of these tests provided confidence of the analytical results that Entergy provided for NRC review. The data from these split sample results are provided in Attachments 2 through 5.

Offsite Sample Results

Based on a review of radiological environmental monitoring program reports, the inspector confirmed that the only detectable radionuclides in the environment attributable to plant operations, as reported by Entergy since 1994, have been low levels of tritium that were expected and detected in the plant discharge canal. The inspector confirmed that releases of radioactive effluents through the discharge canal were monitored and controlled as required by NRC regulatory requirements.

Since October 2005, several offsite samples have been taken at the normal radiological environmental sampling locations, municipal water sources, and other groundwater sampling locations to verify that plant related radioactivity was not being detected beyond the site boundary. The locations sampled included: the Camp Field and Croton Reservoirs (3.3 miles NE and 6.3 miles SE of the plant, respectively), the Trap Rock Quarry, the Fifth Street Well, the Algonquin Creek, the Gypsum Plant outfall, the LaFarge industrial wells, and 3 areas along the Indian Point riverfront in the Hudson River. To date, no radionuclides distinguishable from normal background have been detected in any of these liquid samples taken off site.

Phase 1 OnSite Monitoring Well Sample Results September 29, 2005 - February 27, 2006

	H-3 pCi/l
MW-30	400,000-600,000
MW-31	4000
MW-32	3200
MW-33	142,000-232,000
MW-34	64,000-211,000
MW-35	42,000-104,000
MW-36	47500
MW-37	30000
MW-38	985-1,008
MW-111	113,000-300,000
MW-108	ND
MW-109	ND
U3-1	417
U3-2	512-960
U3-3	439-471
U3-T1	500-800
U3-T2	1,200-2,500

Note: A simplified site diagram showing the above locations as provided in Attachment 7.

Onsite Storm Drain Sample Results September 29, 2005 - February 28, 2006

Unit 2 Storm Drains[2]	H-3 pCi/l
Riverfront: 2, 12, 14, CB15	ND[3]
3, 4, 5	2,000-7,000
Transformer yard: 6	12,000-51,300
Transformer yard: 7, 8	3200-8140
Transformer yard: 17-19	900-1800
80' MOB hill: 9, 10	2140-3000
Unit 3 Storm Drains	
A4	1200
B1-B7	3200-6280
B8	1000
C1	1000
D2	ND
E1-E7	ND

Note: A simplified site diagram showing the above locations as provided in Attachment 8.

NRC licensing requirements specify the environmental lower limit of detection for tritium monitoring offsite at Indian Point Energy Center is 3E-6 uCi/ml or 3000 pCi/l which represents 15% of the EPA drinking water standard of 20,000 pCi/l.

Potential for Strontium-90 Contamination

[2] Turbine building floor drains are routed to the storm drain system. Normal floor drain tritium activity is 1,500 - 3,700 pCi/l due to trace steam generator primary-to-secondary leakage. Therefore, activity in this range may be associated with normal plant design effluent. All storm drains other than those indicated as “riverfront”, are routed into the Indian Point discharge canal, which is a monitored effluent pathway to the Hudson River.

[3] On 12/16/2005 storm drain manhole no. 2 indicated 651 pCi/l based on onsite laboratory measurement and a MDC of 1000 pCi/l. Resampling of manhole no. 2 on 01/04/2006 and 01/19/2006 did not confirm any positive tritium activity.

In mid-February 2006, the New York State Department of Environmental Conservation identified that its October 21, 2005, sample taken from MW-111 (one of the monitoring wells that samples the onsite location having the highest concentration of tritiated groundwater) was determined to contain a small amount of Sr-90, i.e., about 3 pCi/l. Strontium-90 was not detected in samples of MW-111 taken by the NRC on September 29, or October 14, 2005; and Entergy on October 21, 2005, nor in other onsite wells that were sampled at various times. The EPA drinking water limit for Sr-90 is 8 pCi/l. Stakeholders having an interest in IPEC activities were subsequently informed of the results of this sample in a telephone discussion on February 27, 2006.

After being notified by the NYS DEC of their positive indication of strontium-90, the NRC reviewed the sample result and its associated uncertainty. The result indicated 3 ± 2 pCi/l at a 95% confidence level. NRC assessment methodology to conclude certainty of a measurement result is to screen results to a 99% confidence level. At this confidence level the result indicates 3 ± 3 pCi/l, which ensures the result is somewhere between 0 and 6 pCi/l. With 0 included in the range, the NRC could not conclude (based on one sample result), that strontium-90 was positively detected. However, since the potential for strontium-90 has been identified, resampling MW-111 was necessary to confirm the validity of the sample. Coincidentally, on February 7, 2006, MW-111 was re-sampled with split samples taken by New York State, NRC, and Entergy laboratories. Analytical results of these split samples are expected by mid-March 2006. To date, other than actual spent fuel pool water samples, no strontium-90 distinguishable from background, has been detected by the NRC, Entergy, or New York State in any samples collected during the current Indian Point groundwater contamination investigation. However, the licensee's bounding dose calculation discussed in Section 2.b did establish conservative assumptions that included all isotopes identified in the spent fuel leak water, even though most have not been seen in onsite groundwater.

4. Current Indian Point Site Sources of Groundwater Tritium Contamination

A. Unit 2 spent fuel pool liner integrity/lack of a leak collection system

a. Inspection Scope

The Unit 2 spent fuel pool history was reviewed to include design considerations and NRC correspondence relative to a spent fuel pool leak collection system. In addition, the inspection reviewed the licensee's liquid inventory loss calculations based on water makeup and boron concentration reduction to evaluate the ability to detect leakage based on liquid inventory losses. Spent fuel pool water makeup control room logs were reviewed and independent water inventory loss calculations were performed. Observation of accessible spent fuel pool external

walls for signs of leakage and a radiological analysis of samples taken from available onsite monitoring wells and water collection in storm drain systems were also utilized as indicators for Unit 2 spent fuel pool leakage.

b. Findings and Assessment

No findings of significance were identified.

Indian Point Unit 2 was not designed nor licensed with a spent fuel pool liner leak collection system. The design basis specified a dropped fuel cask event causing a spent fuel pool liner break with plant systems designed to protect against fuel pool drain down. Design provisions include pool level instrumentation with alarms in the control room and 150 gallon per minute water makeup capacity in the event of this design basis event. A more recent 1996 NRC initiative looking at plant specific spent fuel storage pool safety, identified the lack of a liner leak collection system at Indian Point Unit 2, however, the principal safety concern was for sufficient decay heat removal and coolant inventory control, which were adequately addressed by the pool level indications in the control room and adequate water makeup and cooling capacity. There was no requirement for a leak collection detection system and the existing plant design was found to be acceptable.

Control room logs provided a record of Unit 2 spent fuel pool makeup, which could provided a means to determine significant long-term water loss due to liner leaks. No detectable trend of fuel pool inventory loss could be determined using this method, given the variability in water evaporation loss due to atmospheric temperature, pressure, and humidity variations.

A possible, more reliable, indicator of significant spent fuel pool water loss was the trending of spent fuel pool boric acid concentration, since boric acid is not affected by evaporative losses and any measurable reduction in boric acid concentration would likely be due to leakage.

A review of daily boron concentration measurements in the Unit 2 spent fuel pool since the last refueling outage, indicated a possible decrease of 7 parts per million (ppm) (normally 2300 ppm). This measurement provides a bounding value of 2.6 gallons per day (gpd) loss, with a large uncertainty of +/- 7.2 gpd. This uncertainty indicates that no definitive loss of spent fuel pool inventory could actually be measured.

Notwithstanding, in the absence of a better bounding estimate of potential loss of spent fuel pool water inventory, Entergy applied an assumed 2.6 gpd loss rate as the basis for the licensee’s source term loss into the ground from the Unit 2 spent fuel pool. This bounding calculation was previously discussed in Section 2 of this report.

A review of preexisting onsite monitoring wells was conducted by the licensee and on October 5, 2005, tritium contamination was detected in monitoring well

MW-111 which was located 250 feet southeast of the Unit 2 spent fuel pool inside the Unit 2 transformer yard. In addition, liquid samples from several onsite storm drain manholes in the vicinity of the Unit 2 transformer yard, also indicated the presence of tritium contamination.

The licensee has pursued consistent efforts to inspect the Unit 2 spent fuel pool liner for evidence of leaks. As of February 28, 2006, approximately 40% of the liner has been inspected by underwater video camera. Six potential locations of interest were examined and tested by vacuum box. No leakage was determined. Notwithstanding, all of the identified locations of interest have been coated to assure integrity. Entergy is exploring other technologies and methods to effect examination of remaining spent fuel pool liner surfaces that are currently inaccessible.

B. Monitoring and control of water inventory in the Unit 1 spent fuel pool system

a. Inspection Scope

The inspectors walked down accessible areas of the North Curtain Drain (NCD) and the Sphere Foundation Drain (SFD). The inspectors also examined the NCDS effluent treatment system, toured the Unit 1 spent fuel pool area, observed on-going spent fuel inspection work, and noted the water levels in the various spent fuel pools. Unit 1 spent fuel pool leak rate data were reviewed by the inspectors, and discussions were held with licensee individuals regarding the Unit 1 spent fuel pools. During this inspection, the NRC obtained samples of the Unit 1 West Spent Fuel Pool, the NCD, and the SFD for the purpose of independent analysis. The NCD sample was taken after the NCD treatment system. The samples were sent to the NRC contract laboratory, the Oak Ridge Institute for Science and Education (ORISE), Environmental Site Survey and Assessment Program (ESSAP) radioanalytical laboratory.

b. Findings and Assessment

No significant findings were identified.

The licensee's efforts to estimate the leak rates from the Unit 1 spent fuel pools were acceptable. The licensee's actions with regard to the Unit 1 spent fuel pool leak rate were well planned and systematic to attempt to identify leakage paths and mitigate leaks. The licensee's future plans call for the dry cask storage of the Unit 1 spent fuel with the subsequent draining of the Unit 1 spent fuel pools. The licensee continues to effectively monitor releases from the systems that collect leakage from the Unit 1 spent fuel pools prior to release to the environment. The inspector verified that all releases are documented in NRC-required annual effluent and environmental monitoring reports.

The Unit 1 spent fuel pool system included six interconnecting pools and the

water storage pool. The pools can be separated with gates and seals. There are two systems which provide pathways for collection of water leakage from the Unit 1 spent fuel pools. These collection systems are the NCD and the SFD. A third system, the South Curtain Drain System, has typically remained dry. The licensee is currently examining the system to assure functionality. These drain systems provided a primary receptor for any water leaked from the Unit 1 spent fuel pools. The SFD depressed the groundwater below the Unit 1 containment, creating a cone of depression, and is expected to intercept any leaks from the Unit 1 spent fuel pools. The NCD is hydraulically connected to the permeable fill placed between the Unit 1 spent fuel pool foundations and the bedrock, and is expected to intercept the Unit 1 spent fuel pool leaks into the permeable fill. The licensee's efforts with regard to Unit 1 spent fuel pool leakage have previously been documented in NRC Inspection Report Numbers 50-03/94-01, 50-03/94-02, and 50-03/94-80.

The Unit 1 leakage collection system has functioned effectively for years to remove isotopes other than tritium as well as, under the state-administered State Pollution Discharge Elimination System (SPDES) permit, to remove any traces of polychorinated biphenyls (PCBs) present in the NCD; the SPDES permit allows no discharge of any detectable PCBs from the facility.

The NCD water is collected in the Unit 1 spray return moat and processed through a treatment system that include charcoal columns for the removal of any detectable PCB contaminants originally present in the NCD water, and then through clay media for the removal of radioactive material (both Cs-137 and Sr-90). The SFD water is collected in a sump and discharged via the R-62 radiation monitor.

Sample results from Unit 1 indicated the expected presence of cesium-137, strontium-90, and tritium in the West Spent Fuel Pool and the NCD samples. The concentrations of Cs-137 and Sr-90 are 5 times and 22 times higher, respectively, than is currently exhibited in the Unit 2 SFP. The SFD sample contained only tritium. The data are presented in Attachment 3 and the complete ORISE analytical data can be viewed in ADAMS at Accession Number ML060720148.

Considering factors including the radiological and non-radiological condition at Unit 1, Entergy has determined that any immediate remediation (such as groundwater pump down) of the existing contaminated groundwater in the vicinity of the Unit 2 transformer yard is not advisable until a more complete characterization of groundwater behavior is established. Such remedial action could adversely affect the current groundwater condition and possibly create a situation in which contaminated water that is currently collected, monitored and discharged from the Unit 1 drain systems in accordance with NRC regulatory requirements and the SPDES permit, is spread elsewhere unnecessarily. Accordingly, the NRC inspectors and the State of New York staff members

involved in onsite discussions expressed agreement that, in the absence of any over-riding public health and safety concern, remediation that could adversely affect the presently understood groundwater conditions is not advisable.

C. Unit 1 spent fuel pool leakage collection efficiency

a. Inspection Scope

Unit 1 has an interconnected system of 6 spent fuel pools and a water storage pool which were epoxy coated cement pools and have been leaking since the early 1990's. There are 160 Unit 1 spent fuel bundles, in the Unit 1 West Spent Fuel Pool, that require a minimum level of water for shielding and convection cooling. All the other pools and the water storage pool are usually drained, however, they have been used occasionally to handle surge volume that is common during periods of heavy precipitation. Inspection review included: Unit 1 spent fuel pool system loss rate studies, and an assessment of a mass balance evaluation of tritium losses from the Unit 1 spent fuel pool system and the Unit 1 drain collection systems.

b. Findings and Assessment

No significant findings have been identified.
A review of 2 separate Unit 1 spent fuel pool loss studies[4] since 1994 using different calculational methods have determined water loss of approximately 25 gallons per day due to cracks in the spent fuel pool walls. A recent January 2006 study[5] by an Entergy consultant reconfirmed this loss rate. In order to investigate the possibility that this may constitute a source of the ground contamination detected in MW-111, the NRC questioned the collection efficiency of the Unit 1 drain system. A tritium mass balance study was completed by the licensee on January 16, 2006, and concluded that the Unit 1 drain system collects approximately seven times more tritium than can be attributed to leakage of the estimated 25 gallon per day from the Unit 1 spent fuel pools. Notwithstanding, the inspectors confirmed that regardless of the source of tritium entering the Unit 1 drain system, all water was collected, monitored and directed to the discharge canal. Entergy is expected to continue investigation of this area as part of its site-wide groundwater characterization effort.

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[4]"Assessment of Groundwater Migration Pathways from Unit 1 Spent Fuel Storage Pool at Indian Point Nuclear Power Plant, Buchanan, New York", July 1994, Whitman Co.; and "Test Result Site Summary Report West Spent Fuel Storage Pool", May 2000, Tanknology Certificate of Underground Storage Tank System Testing.

[5]"Assessment of Leakage from West Fuel Pool during Fuel Cleaning Activities", January 2006, ABS Consulting.

D. Other unknown sources

a. Inspection Scope

Results of onsite sample collection has been reviewed, which include the "Due Diligence" wells that were developed in 2000; and the Unit 3 turbine monitoring wells that were developed in 1998. All nine Phase 1 monitoring wells are established and in use. The installation of fourteen Phase 2 wells is in process and are expected to be completed by April 2006. Sampling of the site's storm drain systems is continuing as part of the groundwater characterization effort.

b. Findings and Assessment

No significant findings were identified.

As expected, tritium is detectable in various secondary systems due to trace primary-to-secondary leakage from the steam generators. Current primary-to-secondary leak rates for both Units 2 and 3 is below minimum detectable levels at <0.1 gpd. The associated turbine building floor sump tritium concentrations for both units is in the range of 1,000 - 4,000 pCi/l.

Entergy's review of the available monitoring well and storm drain data indicates the possibility that there may also be subsurface groundwater contamination in the vicinity of the Unit 3 "B" storm drain system in the area of the Unit 3 transformer yard. Tritium levels in this storm drain system range from 3,200 - 6,280 pCi/l. Unlike Unit 2, the Unit 3 spent fuel pool contains a tell-tale leak collection system, that was inspected during this investigation and found to be in good working condition. No spent fuel pool liner leakage was detected. Entergy plans to continue to investigate and assess this condition as part of the site-wide groundwater characterization effort. The inspectors note that the outfall of the "B" storm drain system is into the discharge canal.

5. Investigation of Other Potential Leaking Structures, Systems or Components

a. Inspection Scope

In addition to the geo-hydrology investigation of groundwater contamination, in October 2005, the licensee initiated a Kepner-Tregoe (K-T) root cause analysis to help identify all possible plant equipment sources, that if leaking, could result in contributing to the subsurface contamination. The results of the K-T analysis were reviewed by the SIT in February 2006.

b. Findings and Assessment

No findings of significance were identified.

The Kepner-Tregoe analysis was aimed at providing a process strategy for eliminating some potential plant equipment sources from consideration and focusing on others in an attempt to determine the source(s) of the current site-wide subsurface contamination measurements. As the groundwater transport study is considered critical to back-tracing groundwater contaminants to their source, the K-T analysis was being used by the licensee to focus on identifying the leaking plant structure(s), and repair or replace to mitigate any ongoing releases to the environment. As of February 2006, the analysis remains incomplete, and the list of potential sources of contamination remains extensive, awaiting further hydrology and other chemical testing information to allow for definitive convergence and identification of the leakage sources. This area will be subject to further NRC review as Entergy progresses with its efforts to find and repair the sources of leakage affecting groundwater.

6. Onsite Tritium Contamination, Groundwater Transport, and Assessment

a. Inspection Scope

The groundwater transport and radiological assessment by members of the NRC SIT was based on several presentations and meetings with the licensee and their geotechnical consultant on: (1) the licensee's evaluation of the extent of the tritium contamination, (2) their Phase 1 effort to locate, install and monitor shallow and deep groundwater monitoring wells, and (3) observations made during field tours of the site. In addition, the licensee provided a "Water Mass Balance and Dose Calculation from Groundwater and Storm Water" draft report, dated February 2006 and the licensee's geotechnical consultant provided an interim report of groundwater transport, dated January 25, 2006, that were reviewed. These reports and meetings were used to understand the current state of knowledge of the groundwater transport of the radionuclide contaminants and its associated radiological impact. This NRC onsite review tested their site conceptual hydro-geologic model and considered alternative explanations for the observed field data. A site conceptual model is being developed to explain preferential pathways in which groundwater and contaminants move through fracture zone, affect water table and confining units, establish connectivity, and migrate to the Hudson River.

b. Findings and Assessment

No significant findings were identified.

The initial site groundwater transport model prepared by the licensee, as of February 28, 2006, was found to be an initial good start to integrate site meteorological, subsurface storm drain, and groundwater monitoring data in order to estimate flow and discharges for estimating releases to the Hudson River. This model appears to be based upon standard industry geotechnical/hydrology principles, with much more site groundwater characterization remaining to be performed in order to adequately predict

groundwater transport offsite. Initial licensee results are provided below. Also provided below is a detailed NRC hydrology assessment. The NRC assessment was conducted by technical specialists from NRC Headquarters. Followup NRC inspections will evaluate the extent to which Entergy's ongoing efforts address the NRC insights and observations herein.

A. Licensee Results

The IPEC site is immediately adjacent to the Hudson River where overall regional groundwater flow would be towards the river with an upward flow direction. This upward groundwater flow from depth would confine the tritium to the shallow groundwater zone. Groundwater flow tends to be along the north-south fracture lines in the bedrock, however, plant construction excavation of the bedrock and backfill of the site is expected to allow significant westward drainage to the Hudson River. The site contains numerous subsurface foundation, footer, and storm drain systems. These drain systems actively depress the local groundwater by rerouting infiltration and limiting recharge, and will influence the direction of groundwater flow.

Similar groundwater elevations and hydraulic response to drilling activities indicate that MW-30 has a high degree of connection with the monitoring wells in the Unit 2 transformer yard (MW-33, MW-34, MW-35 and MW-111). According to the geo-technical consultants this indicates that the contaminated groundwater in the vicinity of the Unit 2 SFP is flowing towards the transformer yard. The other monitoring wells near the Unit 2 SFP crack (MW-31 and MW-32, east and south), have much higher groundwater elevations than those already mentioned, indicating a low degree of connection with MW-30 and a groundwater pressure gradient towards MW-30. Low levels of tritium detected in these two wells is likely due to bedrock fracture zone direction and eastward dip flow direction before reaching the groundwater. The vertical or upward groundwater gradient has not yet been evaluated. This would determine if lower depth water aquifer is rising near the Hudson River as theorized. Utilizing ground penetrating radar, it was determined that the Unit 2 transformer yard consists of a deep deposit of stone backfill which provides a preferential groundwater flow path into the transformer yard. The groundwater elevation in the transformer yard is above the storm-drain system during periods of rainfall, indicating that the storm-drain piping in the transformer yard acts as a drain for the transformer yard, and is a potential source of tritium found in the Unit 2 storm-drain system.

The discharge canal lies between the transformer yard and the Hudson River. Monitoring wells MW-36 and MW-37 (east and west of the discharge canal) both indicate tritium contamination from elevations just below the bottom of the discharge canal. This indicates that tritium is migrating past the discharge canal and potentially into the Hudson River. The pathway may be under the discharge canal or past the north end of the discharge canal. Entergy expects to establish additional wells to clarify this groundwater pathway.

B. ~~NRC Hydrology Assessment~~

The site is built on a hill that tends to fall off in all directions. The presence of surface water like Meahagh Lake, just a few feet above MSL towards the east, and some small streams in forested land southeast of the site suggests that most groundwater flow under the site would occur from local recharge. The licensee observed a strong vertical gradient in some wells during construction indicates the likelihood of a shallow groundwater pathway.

Identification of contaminant sources using tracer tests

The licensee indicates plans to use organic dyes or other dissolved tracers (e.g., bromide) to identify the tritium sources by systematically introducing these tracers adjacent to or within (where feasible) the potential sources of the leaking tritium (e.g., spent fuel pool, primary auxiliary building components, and tanks). At the time of this report, the tracer test strategy was still under development and had not yet been defined. Introduction of the tracers directly into the plant systems would simulate the leaking water streams and groundwater contamination. The use of different tracers at different locations would be used to differentiate the most likely points of contaminant release.

NRC hydrology specialists confirmed that it is important that the migration of the tracers should proceed under ambient conditions at the site, rather that under artificial conditions imposed by large-scale pumping of the monitoring wells. There are two reasons why early remediation through pumping is considered detrimental. First, the natural water drainage pathways through the fractured bedrock, would likely change since the hydraulic head would be increased to the well drainage location. This change could obscure tracing the leak paths back to their sources, which is the main purpose of this investigation; that of identifying the leak sources and repairing them. Second, as discussed in Section 4B, any early uninformed pumping of the groundwater could draw Unit 1 contaminants out of their confined collection system and further spread contamination unnecessarily.

Delineation of transmissive fracture zones, their flow directions and rates

The licensee is currently investigating the main direction of local groundwater flow at the site that controls the transport from and identification of the source(s) of the leaks and pathway offsite. The licensee is appropriately testing the assumption that flow and transport is directly to the Hudson River through analysis of hydraulic head, packer test and tracer test data. The hydraulic connections between the various fracture zones is in the process of being analyzed to determine if bypass flow (short-circuits) between the fracture zones exist, and whether the nonuniformity of the hydraulic heads (elevations) observed in the water table indicates various circuitous routes in the direction of the Inwood Formation strike (i.e., north-south) or dip (i.e., east). This determination would be aided by interpretation of core fracture traces, optical and acoustic televiewer data, and analyses using data from multiple-well packer tests (isolated vertical segments in a well designed to coincide with identified fracture zones) and observations of tracer migration. The licensee is currently testing drilled well boreholes and packer isolating the as-found fracture zones in order to isolate the groundwater transmission zones in the

fractured rock. Additional techniques to provide additional intelligence from the onsite wells include the use of downhole flowmeters, temperature and geochemistry downhole sampling.

Location and rates of subsurface seepage of the tritium into the discharge canal

The licensee is currently investigating whether and how much contaminated groundwater reaches the discharge canal, and whether a significant portion of this flow either passes under the canal, or seeps into it. The current investigation includes the analysis of every ten-minute measurements in water-levels between still wells located both inside and outside of the discharge canal and measurements in monitoring wells (MW) MW-36 and MW-37. Recent indications of tritium concentrations in MW-36 and MW-37 would indicate either a groundwater pathway around the discharge canal to the north or a transmission path under the discharge canal. Additional investigation including relocating MW-52 to intersect the northern path around the discharge canal is currently planned.

Analysis of transport pathways and travel times to the Hudson River

The licensee plans to analyze the water-level monitoring data in MW-36, MW-37, MW-49 and MW-50 to provide the technical bases for understanding the tritium transport direction, and to determine where and at what rate it enters the Hudson River. Indian Point river front surface water split samples have been taken and have not as yet detected any tritium seeping into the Hudson River. Additional sampling from ground-water seepage at the plant's river front should be further investigated for detectable levels of tritium and/or tracers. Other future evaluations include determining the transport velocity and travel times of groundwater contamination to the Hudson River. Future assessment of the licensee's efforts to map the tracer pathways, analyze water-level data to estimate the related hydraulic gradients and transmissivity, and efforts to determine the effective porosity of the rock through various methods including push-pull tracer tests in selected transmissive fracture zones will be evaluated in future inspection activities.

Correlation between local and regional groundwater systems

The licensee has been concentrating on evaluating the local groundwater transport path onsite. The results of this work must ultimately fit the regional groundwater transport system of which it is a part. Future inspection will evaluate the relationship between the local (site) groundwater system conceptual model being developed and the underlying and surrounding regional groundwater hydrology. This effort would be enhanced by the interpretation of groundwater levels in packed-off intervals corresponding to transmissive fracture zones in the deep monitoring wells, and the identification and analysis of unique geochemical signatures in the local and regional groundwater systems. The licensee should use natural or existing anthropogenic tracers (e.g., road salts, hydrocarbons) to the extent possible to understand this relationship between the local and regional groundwater flow systems. The demarcation of these systems should take advantage of geochemical differences between the local Inwood Formation carbonates and the

Manhattan Formation schist rock types, water temperature, human-introduced tracers such as transformer oils, and water additives such as ethanolamine.

The licensee has provided an initial mapping of where local groundwater recharge occurs on the site, and has segregated various areas of the site into areas of likely leakage into storm drains and gravel-covered transformer yards. Seasonal variations in precipitation and periods of freezing may provide additional information to confirm or bound this initial mapping effort. A longer term monitoring program will provide the necessary data and perspective to evaluate the site conceptual model.

Confirm assumptions and test hypotheses in the conceptual model

After the Phase 1 and Phase 2 monitoring wells are installed and data collected and the site conceptual model becomes mature, future licensee activities can evaluate the assumptions about the boundary conditions in the conceptual site model towards the south, particularly between the site and the Trap Rock Quarry, to confirm the hypothesis that the site groundwater flow is directly to the river. Monitoring wells MW-40 and MW-48 would be useful in this regard to determine if there is any subsurface flow parallel to the river towards the south. The licensee should also evaluate the boundary conditions to the east. To test the hypothesis that there is no eastward migration, the locally perched conditions that may currently exist near the Unit 2 spent fuel pool, should be evaluated with data from water levels in monitoring wells MW-30, MW-31, and MW-32, during periods of differing precipitation. Additionally, the hypothesis that groundwater contamination to the east of the Unit 2 spent fuel pool migrated in the unsaturated zone under the influence of gravity following the eastward dip of the main fracture sets in the Inwood formation should be substantiated through other tests, such as tracers, piezometers, tensiometers, and geophysical methods.

The licensee should determine to what extent cross-contamination of the monitoring wells could occur, and what steps are being taken to avoid this potential problem.

C. Conclusions

Entergy has completed an initial set of monitoring wells associated with the expected groundwater pathway from the U2 SFP. This investigation represents only the beginning of establishing a site groundwater transport conceptual model. Early results suggest that the groundwater location of the Unit 2 SFP leak is directly connected to the Unit 2 transformer yard and is responsible for the tritium detected in MW-111. Entergy recently completed and sampled water from two wells (MW-36 and MW-37), that were positioned to determine if contaminated groundwater was migrating under the discharge canal. Tritium was detected in both of these wells. Based on these results and its preliminary hydrological characterization of the site, Entergy concluded that some contaminated groundwater likely will or has already migrated to the Hudson River. The licensee's groundwater transport investigations appear to have a sound basis within the limited time frame provided. There remain several site conceptual model hypotheses to be tested. A detailed NRC hydrology assessment is included in this report, and NRC followup inspections will evaluate Entergy's use of that assessment. The licensee has

been open to NRC and State of New York hydrology questioning and has demonstrated commitment to this investigation.

7. Problem Identification and Resolution

a. Inspection Scope

Inspectors reviewed Entergy's actions to ascertain the origin of the leakage, the extent of condition, extent of cause, and mitigative actions. Inspectors reviewed condition reports, seepage water analyses, well water analyses, action plans, procedures, and 10 CFR 50.59 screening forms to determine if problems were being properly identified, characterized, and entered into the corrective action program for evaluation and resolution. Inspectors reviewed the condition reports associated with the spent fuel pool wall, MW-111, and compared Entergy's disposition of those condition reports with procedures, EN-LI-102, "Corrective Action Process", EN-LI-118, "Root Cause Analysis Process", and EN-LI-119, "Apparent Cause Evaluation (ACE) Process".

The inspectors conducted multiple walkdowns of the excavation adjacent to the south wall of the spent fuel pool, the Primary Auxiliary Building, onsite well locations, and the Fuel Storage Building to identify other conditions and independently verify Entergy's efforts. Inspectors conducted multiple interviews and meetings with Entergy management, engineers, workers, and technicians to identify other areas where problems could be identified. The inspectors reviewed work requests and attended Entergy's daily ISFSI meetings in September 2005 to understand the next steps being planned. Inspectors reviewed Entergy's use of Operating Experience from other licensees' efforts to bound spent fuel pool leakage impacts. Inspectors reviewed the timeliness of Entergy's identification of tritium in well MW-111, other onsite wells, and the efforts with its contractor to further understand onsite hydrology.

b. Findings and Assessment

No significant findings were identified. The inspectors noted that extensive licensee attention and oversight were applied to the evaluation of the SFP south wall leak and the groundwater situation. The inspector's observation of licensee evaluations and groundwater exploration identified some areas where corrective action tools could have been employed in a more orderly manner. For example, some condition reports were classified "apparent cause (low tier)," yet the company's actions encompassed "apparent cause, high tier." The K-T problem analysis could have been more consistently pursued. These issues, described in more detail herein, were considered minor issues by the team.

The team did not identify a reasonable earlier opportunity to identify the SFP wall leakage before the excavation next to the south spent fuel pool wall. Due to the pool design, Entergy could not have foreseen and corrected a spent fuel pool leak of approximately 1 gallon per day through the south or other pool walls from those areas which are below grade level. Since the interior examination of the spent fuel pool liner is ongoing, it is currently unknown if a defect in the stainless steel liner is the cause. The NRC will continue to evaluate any indications found in future fuel pool liner inspections,

and the appropriateness of the corrective actions for those indications.

Entergy first identified a moist crack in the south spent fuel pool wall on August 22, 2005, however, no condition report was written on that day. Inspectors examined the appropriateness of not writing a condition report on August 22, since at that time, it could not be ascertained if the water was originating from dust suppression or the spent fuel pool. Inspectors judged that it was appropriate to not enter this condition into the corrective actions process until September 1 since the crack did not show any removable contamination in prior days. Although the condition was not in the corrective action process in late August, personnel continued to monitor the area while work progressed. This does show a good questioning attitude on the part of Entergy radiation protection technicians and excavation workers who were cognizant of the crack's drying and then re-wetting.

Inspectors observed that Entergy's ability to quantify radioisotopes and chemistry of the seepage was largely a function of the ability to collect a sufficient quantity of water from the south spent fuel pool wall. While a permanently engineered collection system was being designed, a temporary apparatus was installed to collect water and prevent it from contacting the ground. The iterative process of increasing the size of the temporary collection apparatus and its adhesion to the pool wall was done outside the corrective action process. A collection bottle was added to the apparatus on September 15, 2005, which greatly improved Entergy's ability to collect a sufficient volume of water for multiple tests. After appreciable leakage was collected, Entergy had difficulty in ascertaining if the collected water was from a current spent fuel pool leak or from historical events such as the 1992 spent fuel pool leak. Cesium isotope ratios, boron concentration, and the presence of tritium ultimately led to Entergy confirming that the water was recently leaked from the spent fuel pool. Until this time Entergy's efforts had been focused on the immediate area of the south SFP wall. Entergy's extent of cause review was broadened to ascertain the extent of tritium migration, which resulted in sampling of MW-111 and a subsequent large effort from the plant staff and a hydrology contractor.

Inspectors also observed that Entergy identified a need for analysis of concrete rebar corrosion due to boric acid and promptly gathered industry experience to analyze the condition. Inspectors reviewed Entergy's corrective actions thus far to install a permanent leakage collection system attached to the south pool wall, inspect portions of the fuel pool liner, calculate a bounding offsite dose, and plan new onsite wells with its hydrology contractor. These efforts will continue to be assessed by the NRC after this Special Inspection. Entergy's future corrective actions to epoxy coat additional possible defects in the spent fuel pool liner, inspect the lower portions of the spent fuel pool liner, inspect other components containing tritium, and well drilling will be assessed in the future under the Reactor Oversight Process Deviation Memo dated October 28, 2005.

Inspectors reviewed Entergy's efforts in establishing the scope of the problem by reviewing pertinent control room logs, work requests, well drilling plans, action plans, and attending Entergy meetings. Inspectors reviewed Entergy's first iterations of a Kepner-Tregoe (K-T) problem analysis which considers many potential tritium sources

onsite and actions to prove or disprove these sources as a contributor to the tritium contamination. Inspectors noted that at this stage, with the help of a corporate facilitator, the K-T generated corrective actions to review all the possible sources of tritium onsite. Although individuals pursued lines of inquiry consistent with the K-T framework, the analysis was not regularly updated with new information. Entergy refocused the K-T process in February 2006 based on NRC inspectors' feedback. Going forward, the K-T process will seek to prove or disprove certain components as being a contributor of tritium to the onsite groundwater. This K-T process will be revisited by the NRC in the future under the Reactor Oversight Process Deviation Memo dated October 28, 2005.

EN-LI-102, "Corrective Action Process", directs category 'B' condition reports to receive either a high tier apparent or root cause analysis or a lower tier apparent cause analysis. Examples of adverse conditions are given in attachment 9.2 to EN-LI-102 and the examples include unplanned radioactive releases. Procedure EN-LI-119, "Apparent Cause Evaluation (ACE) Process", defines that lower tier apparent cause evaluations are used when the failure mechanism is known or can be readily determined with minimal investigation. Entergy initiated condition reports IP2-2005-03557 and IP2-2005-03986 and assessed them as category 'B' with lower tier apparent cause reviews. The inspectors determined that the 'B' classification was appropriate based on the requirements of Entergy's process however it should have been, as a minimum, treated as requiring a higher tier apparent cause evaluation based on the complexity of the issue and the lack of a clearly identifiable failure mechanism. The higher tier apparent cause requires the same evaluation as a lower tier but also requires a safety analysis and a review of external operating experience. In a review of all the corrective actions associated with this issue, the inspectors noted that these additional elements had been required as specific corrective actions therefore all the elements of a higher tier apparent cause had been established. Based on this fact the inspectors found that the classification as a lower tier apparent cause did not adversely impact the overall evaluation of this issue.

Entergy's very early corrective actions relied heavily on engineering and management oversight to designate appropriate corrective actions as new information was discovered, rather than rapidly iterating the formal corrective action process. Nonetheless, Entergy initiated several corrective actions to examine operating experience, start a Kepner-Tregoe problem solving analysis, and conduct a hydrology study. Entergy initiated a Kepner-Tregoe analysis in October 2005 as a corrective action, and inspectors judged, that while this effort could have been more consistently pursued as discussed previously, the effort was still satisfactory to move Entergy toward finding the source(s) of the tritium in the onsite groundwater. Additionally, condition reports IP2-2005-03557 and IP2-2005-03986 were designated to receive review by the Corrective Action Review Board (CARB), which is a formal review by plant management and diverse departments.

8. ~~Prior Indications of Onsite Groundwater Tritium Contamination~~

a. Inspection Scope

NRC IE Bulletin No. 80-10, “Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment” was published on May 6, 1980. This bulletin required licensees to review their facility design and operations to identify systems that were considered nonradioactive, but could become radioactive through interfaces with radioactive systems, to include leaks and valve misalignments. The Bulletin required that a routine sampling and analysis for the identified plant systems be established in order to identify any contaminating events that could lead to unmonitored, uncontrolled releases to the environment. In response to the Bulletin, both Units 2 and 3 provided lists of plant systems with sampling periods. In addition to these licensing commitments, both Units 2 and 3 included different programs of storm drain sampling. The storm drain sampling data were reviewed from 1998 through 2006. In addition, prior to the sale of Indian Point to Entergy, several “Due Diligence” wells were installed and sampled in March 2000. These results were also included in our review. Final records of past onsite contamination spills, required for future decommissioning of the site as specified in 10CFR50.75(g), were also reviewed for any relevance to the current site condition.

b. ~~Findings and Assessment~~

No findings of significance were identified.

Review of the Unit 2 storm drain system data did not indicate a history of the current extent of elevated tritium contamination. No historical marker was indicated in the storm drain sample data as to when the tritium leaks may have been initiated. Although a review of the Unit 2 storm drain data has not indicated a prior indication of transformer yard tritium contamination, there were two prior recorded instances of elevated tritium activity. On April 11, 2000, manhole no. 3 indicated 3,100,000 pCi/l. This occurrence was investigated and a condition report (CR-IP2-2000-02549) was written which explained the draining of steam generator no. 24 (via the monitored discharge canal) after the February 14, 2000 steam generator tube failure event. There was no evidence of elevated tritium activity in this manhole prior to or after this occurrence. Also, there was 23,200 pCi/l of tritium detected in manhole no. 4A on January 15, 2004, that was not explained by the licensee. This manhole was the last access point to the Unit 2 storm drain system prior to its outfall into the monitored discharge canal, and all upstream manhole samples were of normal tritium activity. This anomaly does not appear to have been addressed by the licensee since no condition report was written. There were no elevated tritium concentrations either before or after this sample was taken. Although the lapse in formally reviewing the unexpected result in early 2004 is a minor issue, it suggests the need to ensure that each IE Bulletin 80-10 program sample receives a focused review and that collective results receive overall evaluation. A review of the IE Bulletin 80-10 program revealed Unit-specific programs without provisions for site-wide review or trending of results. This had been previously identified by the licensee and a condition report was addressing improving this program.

9. ~~Regulatory Requirements~~

A site-wide ground water contamination characterization has progressed significantly,

but has not yet been completed. At this stage in the licensee's ground water contamination investigation, the location of the Unit 2 spent fuel pool liner leak is unknown and other possible sources of leakage into the groundwater are being investigated. A followup NRC report is expected to address the resolution of these onsite leaks, evaluate the significance of any attendant deficiencies in licensee performance, and provide final regulatory conclusions. Currently, the identified ground water release has been classified by the licensee as an abnormal release, and although this is not a normal controlled release, the required surveying, radioactivity accounting and dose impact calculations have been performed. No performance deficiencies in conducting licensee activities have been identified at the present time. Reasonable efforts are currently being made to identify and stop the leak(s). Several specific areas of regulatory compliance were evaluated based on current information, and these results are provided below.

A review of prior issues involving Unit 2 spent fuel pool liner integrity, revealed a prior 1990 spent fuel pool leak and repair that was evaluated and determined that the licensee adequately addressed the cause and corrective actions associated with the prior occurrence. (10 CFR 50, Appendix B, Criterion XVI, Corrective Action)

Historical onsite groundwater sampling data was reviewed to look for any precursor indications of subsurface ground contamination that the licensee should have acted upon and to attempt to date the time period of contamination release. Other than isolated occurrences, the storm drain and monitoring well data did not indicate any historical or ongoing ground contamination condition. (IE Bulletin 80-10, 10 CFR 20.1501, 10 CFR 20.1302)

Once the leaking crack in the Unit 2 spent fuel pool wall was identified, and tritium was detected in MW-111, sufficient surveys of the site were conducted by the licensee to evaluate the extent of the condition by sampling accessible subsurface locations in all currently existing monitoring wells and storm drain systems. (10 CFR 20.1501, 10 CFR 20.1302)

The current identified groundwater release has been classified by the licensee as an abnormal release, as specified in Regulatory Guide 1.21, and will be included in the 2005 effluent release report as required. The current Entergy liquid release and dose calculations indicate release concentrations and public doses that are below the NRC liquid release and public dose requirements. (10 CFR 20, Appendix B; 10 CFR 20.1301; 10 CFR 50, Appendix I)

With respect to reporting requirements of the environmental monitoring program, there have been no results that would require a special report to the NRC. For example, any plant-related radionuclides detected any samples in the environment greater than 10 times the environmental lower limit of detection requirements (e.g., 30,000 pCi/l for tritium) would require a special report. (10 CFR 20.2203)

10. ~~Ongoing issues for continuing NRC inspection activities~~

The following areas are currently envisioned for review during followup NRC inspections.

1. Follow licensee efforts to identify sources of tritium contamination. These include: well data collection and associated groundwater vector analysis, tracer studies (both between fracture zones and from plant components), root cause analysis of potential leaking structures, systems and components.

2. Evaluate repair of leaking components, as well as Entergy's efforts to address groundwater contamination.

3. Evaluate establishment of a site groundwater monitoring program to encompass U2 and U1 SFP leak detection and other potential sources for now and future leak detection.

4. Review Entergy efforts to validate the site conceptual hydrology model that assumes a Hudson River shallow water discharge.

5. Independently review final public dose calculations for all identified groundwater contaminants.

6. Review the consolidation and improvement of the IE Bulletin 80-10 program.

11. Generic Applicability

Contamination of onsite groundwater due to leaking plant structures, systems or components is being reviewed by the NRC as a potential generic issue. Recent groundwater contamination events at various nuclear power plants have received considerable NRC attention. Although no adverse dose impacts have been identified related to these events, there is concern that under different circumstances than have occurred in cases thus far, undetected leakage to the onsite groundwater system can result in areas of groundwater contamination, undetected releases of radioactivity to the unrestricted area, and unevaluated doses to members of the public. The NRC Team Leader and other NRC Region Health Physics specialists closely communicated with NRC Headquarters throughout the inspection, and will continue to do so, as NRC formulates its generic reviews and associated industry communications.

4OA6 Meetings, including Exit

.1 Exit Meeting Summary

The inspectors presented the Special Inspection results to Mr. J. Comiotes and other licensee and New York State representatives on February 28, 2006. The licensee acknowledged the findings presented. Based upon discussions with the licensee, none of the information presented at the exit meeting and included in this report was considered proprietary.

Enclosure

ATTACHMENT 1

Indian Point Unit 2 Spent Fuel Pool Crack Time Line

Date	Event
8/22/05	The Unit 2 spent fuel pool leak was first identified as a moist crack first in the SFP south wall excavation area at approximately 65-foot elevation. Crack swipe samples did not detect any radioactivity. No SFP leak was suspected at that time.
8/26/05	The dry cask storage Project Manager observed the crack. The crack was subsequently observed by structural engineering and was characterized as a normal shrinkage crack during the cement curing process and that there was no indication of structural damage.
9/1/05	Contamination was first detected on a swipe sample of the exposed crack. The NRC resident inspector was informed.
9/2/2005	The NRC Senior Resident Inspector (SRI) was informed of the contaminated crack, which was relayed to NRC Region I management. The licensee had previously used water in their excavation activities, and there had been a contaminated drain line in the excavation area that had been previously removed, so contamination in the area was not unexpected. Therefore, it was not conclusive at that time that there was any leak from the SFP. Entergy conducted a conference call with the NRC conference to discuss their structural characterization of the observed crack.
9/6/2005	To further investigate the possibility of a SFP leak, the licensee assembled an investigation team. Soil samples were taken in the area of the crack.
9/7/2005	The Unit 2 SFP horizontal crack at 65-foot elevation was observed weeping. NRC dispatched an engineering inspector to the site to review the SFP structural integrity this week and made plans to send a health physics inspector the following week to evaluate the radiological impact. A condition report (CR-IP2-2005-03557) was initiated, identifying water weeping at the 65-foot level of the SFP south wall, with a trace amount of cesium-137. The condition report indicated that it was unclear as to the source of the observed water; that it could be from a pinhole leak in the SFP steel liner or due to the excavation activities that included wetting of concrete during cutting operations in the area. A rebar detection device was used to determine that there was rebar 4 inches behind and parallel to the crack.

A one-half inch diameter hole was drilled to a depth of 8 inches into the moist crack revealing dampness in the first several inches, then dry; cesium-134, cesium-137, and cobalt-60 were detected with the highest concentration found on the outside wall. Samples were take for boron testing.

A plastic covering was placed over the moist crack to attempt to capture an actual liquid sample for radiochemistry analysis.

9/8/2005 Two, 4-inch diameter core bores were made into the moist crack at 65-foot elevation to a depth of 4 inches (stopped by rebar).

First quantity of liquid, approximately 2 ml, was collected over a 24-hour period, which was an insufficient amount for tritium measurement.

An NRC structural engineer inspected the SFP wall crack and provided a preliminary assessment that the crack characterization did resemble original concrete curing shrinkage cracks and that the crack and core bores did not affect the SFP wall structural integrity.

9/9/2005 The soil adjacent to the SFP crack was sampled for offsite laboratory tritium analysis.

9/12/2005 After further excavation work a second moist crack was uncovered at the 60-foot elevation.

The SFP wall crack core bore performed on 9/9/2005, showed evidence of moisture.

The first liquid sample large enough for tritium testing was collected from the 65-foot elevation crack (12 ml).

9/13/2005 An NRC health physicist inspector began an onsite inspection to provide a preliminary radiological assessment of the contaminated crack event. Boron analysis of crack water indicates 1265 ppm (versus SFP content of 2300 ppm). The NRC inspector detects error in Cs isotope dating technique by the licensee, and determined the age of the liquid and soil samples to be approximately 5 years, which would indicate an active leak and could not be explained as legacy material from a previously repaired SFP leak, 14 years before.

9/15/2005 NRC inspectors preliminary radiological assessment indicates 100 ml/day spent fuel pool water released directly into the Hudson river with a 1E5 dilution would represent an estimated 2E-5 mrem per year to a maximally exposed member of the public. This provided early confidence that this was of very low dose significance.

9/18/2005 Entergy raised Unit 1 West SFP water level from 48-foot to 56.3-foot elevation for fuel cleaning/inspection work. This evidently increased SFP leakage from 25 gpd to 180 gpd.

9/19/2005 Tritium was detected in SFP south wall crack water samples. Entergy has not determined if this is an active leak or legacy material from the 1992 SFP leak or from the previously removed floor drain piping.

SFP wall crack leak increased to 500 ml per day.

9/20/2005 500 ml per day sample. Previous liquid sample analysis indicates tritium levels similar to the Unit 2 SFP and boron levels approximately half of SFP levels.

NRC Special Inspection Charter was issued, followed by a press release announcing this action.

9/21/2005 Special Inspection entrance meeting conducted at IPEC. NYSEMO and NYSDPS were present at the entrance meeting and toured the SFP leak area.

9/27/2005 The SFP 60-foot elevation crack continues to leak at 500 ml per day.

9/28/2005 With improved liquid collection system installed, SFP south wall indicates 1.3 liters per day leakage.

9/29/2005 Excavation down to base mat depth in northwest corner. No additional water or additional leaking cracks were detected. 1.3 liters per day collected. Entergy treating the leak as an active leak. Legislative staff conference calls with NRC are initiated. These conference calls were held approximately every two weeks thereafter.

10/5/2005 “Due Diligence” wells sampled on 9/29 results were received. MW-111 in the Unit 2 transformer yard indicated 2.11E-4 pCi/l tritium, which is greater than the EPA drinking water standard (2E-5 pCi/l). NRC and stakeholders were notified. NRC Special Inspection Charter was revised on October 7, to include a review of MW-111 tritium contamination and licensee’s efforts to monitor and control water inventory in the Unit 1 SFP system.

10/6/2005 Licensee research indicates that in April 2000, all onsite “Due Diligence” wells were sampled for gamma radionuclides and tritium with no radionuclides detected.

10/7/2005 Ten “Due Diligence” wells and five Unit 3 wells were surveyed for groundwater depth.

10/8/2005 Five additional Unit 3 wells sampled (U3-1,2,3, U3-T1, T2).

10/11/2005 Phase 1 monitoring well proposal was presented by a geotechnical consultant consisting of eight new wells to be drilled to test the theory of tritium direct groundwater transport to the Hudson River. NRC questioning historical manhole sampling as well as possible tritium contribution from leaking Unit 1 spent fuel pools.

Due to one week of heavy rain influent to the NCD, the Unit 1 non-fuel pools were filled as a surge volume. This lowered the Unit 1 West SFP makeup rate to 130 gpd, however, the overall loss rate through the water storage pool was probably the same as the 9/18/2005 log entry.

10/14/2005 NRC acquires seven independent onsite samples for confirmatory measurement at an independent government laboratory (MW-111 original 9/28 sample, MW-111 10/14 sample, Unit 1 West SFP, Unit 2 SFP, NCD effluent, SFDS, and Unit 2 SFP crack liquid).

10/20/2005 Verification that the Unit 2 storm drain system (MH-5, fed by the Unit 2 containment footer drain system with indications of tritium) discharges into the Unit 2 discharge canal.

Bounding leakage loss rate from the Unit 2 SFP based on previous nine months of boron loss of seven parts per million (ppm) determined to be a loss of 2.6 gallons per day (gpd). The 2.6 gpd loss rate provided the licensee input for a bounding dose calculation assuming direct loss to the Hudson River.

NYS DEC (radiation and hydrology specialists) on site for licensee and NRC briefing.

SIT suggests the Unit 1 south curtain drain (SCD) may be plugged and should be investigated. Also, the Unit 3 SFP tell-tail drain system should be verified unblocked and functioning. In addition, the Unit 2 containment footer drain, which reaches near the north end of the Unit 2 SFP, should also be verified as unblocked and monitored for tritium. NRC requests tritium mass balance to determine how much of the Unit 1 SFP leak is not captured by the north curtain drain (NCD) and the sphere foundation drain (SFD).

NYS DEC suggests to SIT that the USGS maybe useful for background hydrology information about the site.

10/21/2005 SIT interim debrief with IPEC site vice president. The NRC was concerned the Unit 1 SCD maybe plugged and should be investigated. Other existing drain systems should also be investigated to verify that they are working and providing accurate information (Unit 3 SFP leak collection system and the Unit 2 containment footer drain system). Unit 1 SFP leak: is represented by 2% of collected leakage from NCD, and 98% from SFD. Unit 1 SFP leakage tritium mass balance still needs to be reviewed. The Hudson River composite samples of plant discharge in 2004 indicated tritium. However, the NRC identified that the REMP composite sampler is actually located inside the discharge canal and not

in the Hudson River to include near field dilution as stated in the ODCM. The investigation needs to be broadened to include other sources besides the Unit 2 SFP. The use of other chemical or radioactive tracers should be used to help discriminate sources.

NYS took eight water samples at: MW-111, Unit 2 CST, U3-1,2,3,4, U3-T1, T2.

An initial licensee bounding calculation based on 2.6 gpd discharge and a 1E5 dilution would result in quarterly dose to the maximally exposed member of the public of 2.2E-5 mrem total body, 3.2E-5 mrem maximum organ dose.

10/27/2005 Unit 2 SFP liner inspection begins with camera inspection in southwest corner.

Licensee hydrology consultant issues Phase 1 ground monitoring proposal.

11/2/2005 Ongoing work to quantify Unit 1 SFP water inventory balance since 9/18/2005 floodup: final destination for leaking SFP system is the water storage pool. Its inspection indicates a water level of 2 feet and that its level has been going down 20 gpd over a one-week period, which equates to 175 gpd loss from the Unit 1 SFP system into the ground/french drain collection system. Due to the relatively higher Unit 1 SFP loss rate than Unit 2 SFP (175 gpd versus 2.6 gpd), although the tritium concentration is 1/50 of Unit 2, that equates to the same potential tritium loss to the ground. The difference is, Unit 1 has a french drain collection system.

The IE Bulletin 80-10 program results going back to 2000 when MW-111 was sampled and tritium was not detected, were requested from the licensee. The dispersal of IE Bulletin 80-10 requirements into the chemistry sampling schedule and the separate programs between Units 2 and 3, are requiring some research by the licensee. Unit 2 and 3 secondary steam tritium content measured in turbine building sumps that discharge to the storm drain system is 1E-6 - 3.7E-6 uCi/ml.

The Unit 3 SFP tell-tail drain system was inspected by boroscope/snake and was found to be unblocked and dry.

U2 SFP south wall crack is leaking 1.3 liters per day.

Underwater camera inspections of Unit 2 SFP revealed three indications between 75-foot and 78-foot elevation in the south west corner of the Unit 2 SFP.

11/3/2005 Entergy meeting on site with congressional and local government staff representatives as well as various New York State offices and NRC Region 1.

Project overview and radiological sample summaries were provided followed by tours of the Unit 2 SFP excavation area and existing monitoring well locations on site.

11/4/2005 Licensee submitted a non-required 30-day report to the NRC dated 11/3/2005, based on tritium results for MW-111 above REMP reporting levels (3E-5 uCi/ml). MW-111 is an onsite well. Since MW-111 does not provide environmental sample data, no NRC report was actually required.

11/7/2005 First Phase 1 monitoring well being drilled (MW-30) 6 feet from Unit 2 SFP cracks.

11/8/2005 Diver enters Unit 2 SFP to perform vacuum box testing of two visible indications. No leak was detected.

11/10/2005 Began drilling first monitoring well (MW-30) inside FSB.

11/17/2005 After the conclusion of Unit 1 West SFP fuel cleaning and inspection activities, the west SFP water level was reduced back down to prior level of 49-foot elevation. The other Unit 1 SFPs are still at various fill levels due to high rain NCD water surge storage.

Diver vacuum tested third SFP liner indication. No leak was detected.

11/22/2005 Unit 2 SFP south wall leak decreased to 70 ml per 24 hours. Unit 2 SFP liner inspection completed in accessible areas (40% of pool). Received initial IE Bulletin 80-10 historical data from licensee.

Received final Unit 2 SFP boron loss pool leakage calculation at 2.6 ± 7.2 gpd error. Water volume is not changing significantly over time (9 months).

11/28/2005 MW-30 drilling was previously completed with packer testing performed on 11/24/2005. Unit 2 SFP south wall seepage reduced to 60 ml per 4 days.

11/29/2005 Unit 2 SFP south wall crack seepage <10 ml per 24 hours.

11/30/2005 NYS DEC split water samples taken with NRC and Entergy at four offsite locations (fifth street well, Algonquin Creekoutfall, Trap Rock Quarry and Gypsum Plant outfall).

12/2/2005 MW-38 drilling completed and developed. Tritium and salinity samples taken.

12/5/2005 Water level monitoring transducer installed in MW-30. Began drilling MW-35.

12/6/2005 Unit 2 SFP south wall seepage less than 10 ml per day.

12/7/2005 MW-35 drilling completed. MW-34 drilling started.

12/6/2005 Two water samples obtained from two onsite LaFarge Gypsum Plant wells (nos. 1, 3).

12/8/2005 Four water sample splits taken by NYS DEC, NRC and Entergy. (MW-38, MW-101, MW-105, MW-107)

12/12/2005 MW-34 and MW-33 drilled and developed.

12/13/2005 Water samples taken from two transformer yard monitoring wells (MW-35, and 34)

12/14/2005 Unit 2 SFP south wall seepage less than10 ml per day.

12/15/2005 Began drilling MW-31. Purging MW-33 for first sample. Unit 2 SFP south wall crack collected 100 ml over a one week period.

12/16/2005 MW-33, 34, 35 well heads installed. Unit 2 storm drain manholes sampled.

12/19/2005 Tritium results obtained for Unit 2 manholes.

12/20/2005 MW-31 drilling completed.

12/21/2005 MW-33, 34, 35 and MW-111 tritium samples reflect similar results with the highest at MW-111 (190,000 pCi/l). Entergy notified the NRC that Unit 2 manhole no. 6 (located 84 feet from MW-111) showed relatively high tritium levels 51,000 pCi/l - greater than 20,000 pCi/l EPA drinking water standard, however, this discharges into the discharge canal and is monitored. All Unit 2 manholes are currently being sampled.

1/3/2006 MW-32 drilling initiated (to -120 foot elevation). MW-38 indicated 985 pCi/l tritium. The unit 2 SFP leak has not provided any liquid collection since 12/21/05.

1/5/2006 MW-31 sample indicates 4000 pCi/l tritium. This monitoring well is 50 feet east of MW-30.

1/10/2006 MW-32 drilling completed. MW-36 being readied for drilling (access path for moving drilling equipment into position is difficult). Four manholes discharge directly to the Hudson River rather than the discharge canal. On 12/16/05, MH-2 indicated 651 pCi/l. Current sampling of all four manholes (MH-1,2,12,14) all indicate less than MDA. A dye test was performed from MH-2 indicating release to the Hudson River, but not through MH-1 indicating a possible break in the storm drain pipe between MH-1 and MH2.

1/12/2006 MW-31 temporary packer installed. MW-38 12/8/2005 sample split results were comparable: Entergy, 985 pCi/l; NYS, 701 pCi/l.

1/13/2006 Unit 2 SFP crack permanent leak collection box installed. NRC notified of

positive tritium results up to 6300 pCi/l detected in various Unit 3 storm drain system manholes. All Unit 3 storm drain systems discharge into the discharge canal, which is a monitored release path.

1/18/2006 Began drilling MW-36.

1/19/2006 Began drilling MW-40 and MW-48 (Phase 2 wells).

½7/2006 MW-31 and MW-32 wells developed with packers installed.

½8/2006 MW-36, MW-40, and MW-48 well drilling completed.

1/30/2006 Began drilling MW-39. MW-30 developed, sampling begun.

1/31/2006 NRC Special Inspection team on site to review Phase 1 monitoring well hydrology results.

2/2/2006 Began drilling MW-37. MW-36 well has been developed. Unit 1 south curtain drain (SCD) initial inspection of first 15 feet was clear. More inspection to follow.

2/6/2006 MW-40 and MW-48 developed.

2/7/2006 NRC, NYS, and IPEC monitoring wells and offsite location split samples taken.

2/8/2006 NRC Special Inspection team on site for IE Bulletin 80-10, 10 CFR 50.75(g) and chemistry counting quality control followup. Hudson River plant waterfront sample splits taken with NRC, NYS and IPEC.

2/10/2006 MW-37 and MW-39 drilling completed. After collection box installation and water leak test, the first sample from Unit 2 SFP leak collection box resulted in 225 ml @ 1/100 tritium concentration, which is indicative of 2.2 ml collection diluted by water leak test.

2/13/2006 No water collected from Unit 2 SFP leak collection box.

2/14/2006 MW-36 initial sample result = 47,500 pCi/l. Onsite operational experience seminar on tritium groundwater contamination attended by: Salem, Seabrook, Brookhaven National Laboratory, Haddam Neck, Yankee Rowe, and consultants.

2/15/2006 Began drilling MW-41, and MW-46.

2/21/2006 NRC was notified by NYS, that Sr-90 was detected in MW-111 at 3 pCi/l.

2/24/2006 MW-37 was developed and sampled.

2/27/2006 MW-37 initial sample result = 30,000 pCi/l, indicating potential tritium release to the Hudson River. A special stakeholder conference call was made to discuss this information as well as potential indications of Sr-90 in MW-111.

2/28/2006 Licensee provided a revised dose calculation of 1.5E-5 mrem/yr to the maximally exposed member of the public based on a general site area hydrology water transport and multiple contamination area drainage into the Hudson River. The NRC conducted the SIT exit meeting.

ATTACHMENT 2

Comparison of Indian Point Monitoring Well Positive Analytical Results

Sample ID	Radionuclide	NRC Result (picoCuries per liter) with reported uncertainty	Indian Pt. Result (picoCuries per liter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (picoCuries per liter)
Monitoring Well MW-111 9/29/2005	H-3	216,800 ± 2,800	207,000 ± ? 211,600 ± 800	Agreement Agreement	Sample not Split with New York
Monitoring Well MW-111 10/14/2005	H-3	7,290 ± 410	6,820 ± ?	Agreement	Sample not Split with New York
Monitoring Well MW-38 12/8/2005	H-3	740 ± 130	980 ± 290	Agreement	700 ± 120

ATTACHMENT 3

Comparison of NRC and Indian Point Inplant Positive Analytical Results

Sample ID	Radionuclide	NRC Result (microCuries per milliliter)	Indian Pt. Result (microCuries per milliliter)	Licensee Result Compared to NRC Result
Unit 1 Sphere Foundation Drain Sump 10/19/2005	H-3	(5.7±2.6)E-7	(8.53±?)E-7	Agreement
Unit 1 West Spent Fuel Pool 10/20/2005	Co-60 Cs-137 H-3 Sr-90	(2.98±0.35)E-5 (6.74±0.22)E-3 (4.18±0.72)E-4 (1.300±0.035)E-4	(3.76±0.32)E-5 (8.13±0.04)E-3 (4.16±?)E-4[1] (3.27±?)E-4[2] Not Analyzed	Agreement Agreement No Comparison No Comparison No Comparison
Unit 2 Spent Fuel Pool 10/21/2005	Co-58 Co-60 Cs-134 Cs-137 H-3 Sr-90	(3.46±0.16)E-4 (7.95±0.28)E-4 (8.57±0.31)E-4 (1.319±0.046)E-3 (2.929±0.083)E-2 (5.87±0.24)E-6	(3.33±0.0.06)E-4 (7.99±0.08)E-4 (1.031±0.0.008)E-3 (1.586±0.012)E-3 (2.52±?)E-2[3] Not Analyzed	Agreement Agreement Agreement Agreement No Comparison No Comparison

ATTACHMENT 3

Comparison of NRC and Indian Point Inplant Positive Analytical Results (Continued)

Sample ID	Radionuclide	NRC Result (microCuries per milliliter)	Indian Pt. Result (microCuries per milliliter)	Comparison (Licensee Result Compared to NRC Result)
Unit 2 Spent Fuel Pool Wall Leak 10/24/2005	Co-60 Cs-134 Cs-137 H-3 Sr-90	(4.56±0.49)E-8 (2.64±0.12)E-7 (4.88±0.15)E-6 (2.208±0.047)E-2 (3.70±0.12)E-7	<8E-8 (3.6±0.8)E-7 (4.73±0.24)E-6 (2.19±?)E-2 Not Analyzed	No Comparison Disagreement Agreement Agreement No Comparison
Unit 1 North Curtain Drain Composite 10/21/2005	Cs-137 H-3 Sr-90	(4.48±0.42)E-8 (1.425±0.053)E-5 (9.97±0.42)E-8	<2E-7 (1.29±?)E-5[4] Not Analyzed	Not Detected/No Comparison No Comparison No Comparison

ATTACHMENT 4

Indian Point Monitoring Well and Offsite Sample Analytical Results Comparison
(Positive NRC Results are in Bold)

Sample ID	Radionuclide	NRC Result (picoCuries per liter) with reported uncertainty	Minimal Detectable Concentration (MDC)	Indian Pt. Result (picoCuries per liter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (picoCuries per liter)
Monitoring Well MW-111 9/29/2005	Co-58	2.7 ± 4.3	<0.34	<5	Not Detected/No Comparison	Sample not Split with New York
	Co-60	3.5 ± 3.1	<0.34	<2	Not Detected/No Comparison	
	Cs-134	-0.5 ± 3.9	<0.34	<4	Not Detected/No Comparison	
	Cs-137	-0.9 ± 2.9	<0.34	<4	Not Detected/No Comparison	
	H-3	**216,800 ± 2,800**		207,000 ± ?	Agreement	
				211,600 ± 800	Agreement	
	Sr-90	1.4 ± 1.2	<2.1	Not Analyzed	Not Detected/No Comparison	
Monitoring Well MW-111 10/14/2005	Co-58	-0.7 ± 2.3	<0.34	<60	Not Detected/No Comparison	Sample not Split with New York
	Co-60	1.8 ± 2.2	<0.34	<40	Not Detected/No Comparison	
	Cs-134	1.9 ± 2.2	<0.34	<40	Not Detected/No Comparison	
	Cs-137	-2.1 ± 3.6	<0.34	<50	Not Detected/No Comparison	
	H-3	**7,290 ± 410**		6,820 ± ?	Agreement	
	Sr-90	1.1 ± 1.3	<2.2	Not Analyzed	Not Detected/No Comparison	
Monitoring Well MW-38 12/8/2005	Co-58	-1.5 ± 3.7	<5.9	<3	Not Detected/No Comparison	
	Co-60	0.3 ± 3.3	<5.9	<3	Not Detected/No Comparison	
	Cs-134	4.4 ± 3.3	<5.9	<3	Not Detected/No Comparison	
	Cs-137	-0.7 ± 3.0	<5.9	<3	Not Detected/No Comparison	
	H-3	**740 ± 130**		980 ± 290	Agreement	700 ± 120
	Sr-90	0.4 ± 1.2	<2.1	<12.5	Not Detected/No Comparison	

Sample ID	Radionuclide	NRC Result (picoCuries per liter) with reported uncertainty	Minimal Detectable Concentration (MDC)	Indian Pt. Result (picoCuries per liter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (picoCuries per liter)
Monitoring Well MW-101 12/8/2005	Co-58	-0.2 ± 3.1	<5.9	<3	Not Detected/No Comparison	
	Co-60	2.5 ± 3.6	<5.9	<4	Not Detected/No Comparison	
	Cs-134	1.8 ± 3.4	<5.9	<3	Not Detected/No Comparison	
	Cs-137	-1.4 ± 5.3	<5.9	<3	Not Detected/No Comparison	
	H-3	70 ± 120	<200	270±280	Not Detected/No Comparison	<50
	Sr-90	0.2 ± 1.1	<2.0	<12.5	Not Detected/No Comparison	
Monitoring Well MW-105 12/8/2005	Co-58	1.5 ± 3.3	<5.9	<4	Not Detected/No Comparison	
	Co-60	1.5 ± 3.3	<5.9	<4	Not Detected/No Comparison	
	Cs-134	0.4 ± 3.5	<5.9	<4	Not Detected/No Comparison	
	Cs-137	0.4 ± 2.9	<5.9	<4	Not Detected/No Comparison	
	H-3	-10 ± 120	<200	220±270	Not Detected/No Comparison	100 ± 90
	Sr-90	-0.2 ± 1.2	<2.1	<19.3	Not Detected/No Comparison	
Monitoring Well MW-107 12/8/2005	Co-58	1.7 ± 2.7	<5.9	<3	Not Detected/No Comparison	
	Co-60	-0.2 ± 2.6	<5.9	<4	Not Detected/No Comparison	
	Cs-134	2.5 ± 2.8	<5.9	<5	Not Detected/No Comparison	
	Cs-137	-1.1 ± 2.4	<5.9	<3	Not Detected/No Comparison	
	H-3	130 ± 120	<200	130±270	Not Detected/No Comparison	<50
	Sr-90	0.8 ± 1.2	<2.0	<13.3	Not Detected/No Comparison	

Sample ID	Radionuclide	NRC Result (picoCuries per liter) with reported uncertainty	Minimal Detectable Concentration (MDC)	Indian Pt. Result (picoCuries per liter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (picoCuries per liter)
Trap Rock Quarry 11/30/2005	Co-58	0.4 ± 1.7	<5.9	<3	Not Detected/No Comparison	<0.9
	Co-60	-0.1 ± 2.1	<5.9	<2	Not Detected/No Comparison	<0.5
	Cs-134	-0.4 ± 1.8	<5.9	<3	Not Detected/No Comparison	<1.2
	Cs-137	0.6 ± 1.6	<5.9	<2	Not Detected/No Comparison	<1.1
	H-3	40 ± 120	<210	-120 ± 270	Not Detected/No Comparison	90 ± 60
	Sr-90	0.9 ± 1.0	<1.7	<20.7	Not Detected/No Comparison	<0.4
Algonquin Outfall 11/30/2005	Co-58	1.1±2.3	<5.9	<4	Not Detected/No Comparison	<1.5
	Co-60	-0.5±2.2	<5.9	<5	Not Detected/No Comparison	<1.4
	Cs-134	0.5±2.4	<5.9	<4	Not Detected/No Comparison	<1.7
	Cs-137	-1.6±2.2	<5.9	<3	Not Detected/No Comparison	<1.5
	H-3	30±120	<210	60 ± 280	Not Detected/No Comparison	<60
	Sr-90	0.3±1.0	<1.8	<20.7	Not Detected/No Comparison	0.7 ± 0.4
Fifth Street Well 11/30/2005	Co-58	0.9 ± 2.2	<5.9	<3	Not Detected/No Comparison	<1.8
	Co-60	0.8 ± 2.6	<5.9	<3	Not Detected/No Comparison	<1.9
	Cs-134	-0.1 ± 2.1	<5.9	<3	Not Detected/No Comparison	<1.9
	Cs-137	-0.6 ± 2.1	<5.9	<3	Not Detected/No Comparison	<1.9
	H-3	-70 ± 120	<210	-70 ± 270	Not Detected/No Comparison	<60
	Sr-90	0.4 ± 1.0	<1.8	<12.6	Not Detected/No Comparison	0.8 ± 0.7

Sample ID	Radionuclide	NRC Result (picoCuries per liter) with reported uncertainty	Minimal Detectable Concentration (MDC)	Indian Pt. Result (picoCuries per liter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (picoCuries per liter)
Gypsum Plant Stream 11/30/2005	Co-58	0.0 ± 1.9	<5.9	<3	Not Detected/No Comparison	<2
	Co-60	0.1 ± 1.8	<5.9	<4	Not Detected/No Comparison	<1.7
	Cs-134	0.1 ± 2.1	<5.9	<3	Not Detected/No Comparison	<1.9
	Cs-137	-0.3 ± 1.7	<5.9	<3	Not Detected/No Comparison	<1.7
	H-3	10 ± 120	<210	60±280	Not Detected/No Comparison	<60
	Sr-90	0.5 ± 1.0	<1.8	<15.2	Not Detected/No Comparison	0.8 ± 0.4
Lefarge Gypsum Plant Well #3 12/6/2005	Co-58	0.4±2.5	<5.9	<3	Not Detected/No Comparison	
	Co-60	0.3±3.1	<5.9	<3	Not Detected/No Comparison	
	Cs-134	3.8±2.8	<5.9	<3	Not Detected/No Comparison	
	Cs-137	-0.8±4.4	<5.9	<4	Not Detected/No Comparison	
	H-3	20±120	<210	110±270	Not Detected/No Comparison	<50
	Sr-90	0.1±1.0	<1.7	<13.6	Not Detected/No Comparison	
Lefarge Gypsum Plant Well #1 12/6/2005	Co-58	-2.8 ± 3.2	<5.9	<4	Not Detected/No Comparison	
	Co-60	0.8 ± 3.9	<5.9	<4	Not Detected/No Comparison	
	Cs-134	0.3 ± 3.6	<5.9	<4	Not Detected/No Comparison	
	Cs-137	0.2 ± 3.5	<5.9	<4	Not Detected/No Comparison	
	H-3	40 ± 120	<210	80 ± 270	Not Detected/No Comparison	<50
	Sr-90	1.2 ± 1.1	<1.8	<14.8	Not Detected/No Comparison	

Attachment 4 Notes:

1. Reported Uncertainties: Because radioactivity decay is a statistical process, radioactive measurement results are reported with a statistical uncertainty combined with other measurement uncertainties into a total uncertainty. For NRC and New York State reported uncertainties, the value following the " ± " represents, in statistics, the 95% confidence interval based on total propagated uncertainties. Indian Point reported uncertainties represent the 95% confidence interval based on counting uncertainty.

2. Minimum Detectable Concentration (MDC) is another statistically derived value that is dependent on measurement process variables, including background, count time, sample size, and the detection system. The MDC is the smallest concentration of radioactive material in the sample, which may be expected to be detected from background at some probability by the measurement process. For this table, the MDC is the smallest concentration of radioactive material in a sample that will be detected from background with a 95% probability with a 5% probability of falsely concluding that a background sample will be considered to contain radioactive material.

3. For NRC results, the actual analytical result is reported, even if that result would be considered not detected. The concentration reported is the value with the plus or minus uncertainty. See Note 1 above. A result is considered not detected or be zero if it is negative or if the result is less than or equal to three times the standard deviation. A result that is considered detected has radioactivity greater than three times the standard deviation, and the result is confirmed positive with 99.9% confidence.

4. Indian Point used an offsite contractor laboratory for the Sr-90 analyses, and their onsite laboratory or offsite environmental laboratory for all other analyses reported here.

5. Only State of New York samples split with NRC are included in this table.

ATTACHMENT 5
Indian Point Inplant Sample Analytical Results Comparison
(Positive NRC Results are in Bold)

Sample ID	Radionuclide	NRC Result (microCuries per milliliter)	Minimal Detectable Concentration (microCuries per milliliter)	Indian Pt. Result (microCuries per milliliter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (microCuries per milliliter)
Unit 1 Sphere Foundation Drain Sump 10/19/2005	Co-58 Co-60 Cs-134 Cs-137 H-3 Sr-90	(-5±24)E-10 (-8±23)E-10 (-1.9±2.3)E-9 (9±22)E-10 **(5.7±2.6)E-7** (-0.2±1.2)E-9	[<3.4E-10] [<3.4E-10] [<3.4E-10] [<3.4E-10] [<2.1E-9]	<8E-8 <8E-8 <1E-7 <1E-7 (8.53±?)E-7 Not Analyzed	Not Detected/No Comparison Not Detected/No Comparison Not Detected/No Comparison Not Detected/No Comparison Agreement Not Detected/No Comparison	Sample not Split with New York
Unit 1 West Spent Fuel Pool 10/20/2005	Co-58 Co-60 Cs-134 Cs-137 H-3 Sr-90	(-5±18)E-7 **(2.98±0.35)E-5** (2±14)E-7 **(6.74±0.22)E-3** **(4.18±0.72)E-4** **(1.300±0.035)E-4**	[<3.4E-10] [<3.4E-10]	<2E-6 (3.76±0.32)E-5 <2E-6 (8.13±0.04)E-3 (4.16±?)E-4[1] (3.27±?)E-4[2] Not Analyzed	Not Detected/No Comparison Agreement Not Detected/No Comparison Agreement No Comparison No Comparison No Comparison	Sample not Split with New York
Unit 2 Spent Fuel Pool 10/21/2005	Co-58 Co-60 Cs-134 Cs-137 H-3 Sr-90	**(3.46±0.16)E-4** **(7.95±0.28)E-4** **(8.57±0.31)E-4** **(1.319±0.046)E-3** **(2.929±0.083)E-2** **(5.87±0.24)E-6**		(3.33±0.0.06)E-4 (7.99±0.08)E-4 (1.031±0.0.008)E-3 (1.586±0.012)E-3 (2.52±?)E-2[3] Not Analyzed	Agreement Agreement Agreement Agreement No Comparison No Comparison	Sample not Split with New York

Sample ID	Radionuclide	NRC Result (microCuries per milliliter)	Minimal Detectable Concentration (microCuries per milliliter)	Indian Pt. Result (microCuries per milliliter)	Comparison (Licensee Result Compared to NRC Result)	State of New York Result (microCuries per milliliter)
Unit 2 Spent Fuel Pool Wall Leak 10/24/2005	Co-58 Co-60 Cs-134 Cs-137 H-3 Sr-90	(2.4±3.4)E-9 **(4.56±0.49)E-8** **(2.64±0.12)E-7** **(4.88±0.15)E-6** **(2.208±0.047)E-2** **(3.70±0.12)E-7**	[<3.4E-10]	<5E-8 <8E-8 (3.6±0.8)E-7 (4.73±0.24)E-6 (2.19±?)E-2 Not Analyzed	Not Detected/No Comparison No Comparison Disagreement Agreement Agreement No Comparison	Sample not Split with New York
Unit 1 North Curtain Drain Composite 10/21/2005	Co-58 Co-60 Cs-134 Cs-137 H-3 Sr-90	(-1.4±1.8)E-9 (0.0±2.1)E-9 (-6±19)E-10 **(4.48±0.42)E-8** **(1.425±0.053)E-5** **(9.97±0.42)E-8**	[<3.4E-10] [<3.4E-10] [<3.4E-10]	<1E-7 <1E-7 <1E-7 <2E-7 (1.29±?)E-5[4] Not Analyzed	Not Detected/No Comparison Not Detected/No Comparison Not Detected/No Comparison Not Detected/No Comparison No Comparison No Comparison	Sample not Split with New York

Attachment 5 Notes:

1. Reported Uncertainties: Because radioactivity decay is a statistical process, radioactive measurement results are reported with a statistical uncertainty combined with other measurement uncertainties into a total uncertainty. For NRC and New York State reported uncertainties, the value following the " ± " represents, in statistics, the 95% confidence interval based on total propagated uncertainties. Indian Point reported uncertainties represent the 95% confidence interval based on counting uncertainty.

2. Minimum Detectable Concentration (MDC) is another statistically derived value that is dependent on measurement process variables, including background, count time, sample size, and the detection system. The MDC is the smallest concentration of radioactive material in the sample, which may be expected to be detected from background at some probability by the measurement process. For this table, the MDC is the smallest concentration of radioactive material in a sample that will be detected from background with a 95% probability with a 5% probability of falsely concluding that a background sample will be considered to contain radioactive material.

3. For NRC results, the actual analytical result is reported, even if that result would be considered not detected. The concentration reported is the value with the plus or minus uncertainty. See Note 1 above. A result is considered not detected or be zero if it is negative or if the result is less than or equal to three times the standard deviation. A result that is considered detected has radioactivity greater than three times the standard deviation, and the result is confirmed positive with 99.9% confidence.

4.Indian Point used an offsite contractor laboratory for the Sr-90 analyses, and their onsite laboratory or offsite environmental laboratory for all other analyses reported here.

5.Only State of New York samples split with NRC are included in this table.

ATTACHMENT 6

October 7, 2005

MEMORANDUM TO: John R. White, Manager
Special Inspection

James D. Noggle, Senior Inspector
Special Inspection

FROM: A. Randolph Blough, Director **/RA/**
Division of Reactor Safety

SUBJECT: SPECIAL INSPECTION CHARTER - INDIAN POINT UNIT NO. 2 (UPDATED)

This memorandum updates my memorandum of September 20, 2005, instructing you to complete a special inspection at Indian Point 2.

Background:

Indian Point Unit 2 has been conducting excavation of the Fuel Storage Building (FSB) Loading Bay adjacent to the south wall of the Spent Fuel Pool (SFP) in preparation for installation of a gantry crane required to complete the Independent Spent Fuel Storage Installation Project. In early September while removing material along the south wall of the SFP, several 1/64" wide cracks were found. Two of these cracks exhibited wetness along the seams. Collected leakage from these seams has been small; recently Entergy staff efforts to collect leakage have yielded less than a pint a day. Subsequently, Entergy initiated actions to assess this condition and informed the NRC.

The moisture collected from these cracks and immediately adjacent soil have been analyzed and found to have the radiological characteristics of spent fuel pool water. However, to date, the licensee has been unable to establish if the material is due a previous leak that was detected in the early 1990's and subsequently repaired, or is of more recent origin.

On October 5, 2005, Entergy reported that some tritium activity had been identified in one onsite ground monitoring well. Three other monitoring wells showed no detectable activity and other samples were being analyzed.

Information and observations to date continue to suggest that the condition does not currently pose any actual health and safety concern or adverse impact to the environment. On September 20, NRC Region I had deemed it prudent to conduct a special inspection since the nature and extent of the condition are not yet completely known, and in view of the technical complexity of the issue. This memorandum updates the charter to account for new information learned since then.

This Special Inspection was initiated in accordance with NRC Management Directive 8.3, “NRC Incident Investigation Program.” The purpose is to better understand the source of the radiological contamination, the cause, the extent of condition, and any potential impact on spent fuel pool integrity.
The inspection will be performed in accordance with the guidance of NRC Inspection Procedure

93812, “Special Inspection,” and the inspection report will be issued within 45 days following the exit meeting for the inspection.

Objectives of the Special Inspection:

The objectives of this Special Inspection are to evaluate the circumstances associated with the conditions described above. The objectives and inspection tasks are amplified in the attached charter. In the event that information is determined that the nature of these conditions are significantly different than currently understood, i.e., the circumstances and conditions may be beyond the scope of a Special Inspection, the Lead Inspector will immediately inform the Special Inspection Manager.

Team Composition:

The team will be:

Manager:	John R. White, Chief, Division of Reactor Safety Plant Support Branch 2
Lead Inspector :	James D. Noggle, Senior Health Physicist, DRS
Members:	Suresh K. Chaudhary, Health Physicist, DNMS (part-time) Mark Cox, Senior Resident Inspector, IP2 (part-time) Chris Long, Resident Inspector, IP2 (part-time) Robert Bores, Health Physicist, ORA (part-time) James Kottan, Health Physicist, DNMS (part-time) Dr. Richard Codell, Hydrologist, NMSS (part-time)

Schedule:

Onsite inspection effort was conducted following identification of the cracks. The decision for a special inspection was made on September 20, 2005. The licensee’s excavation activities and response efforts will be monitored by resident inspectors and the Team Leader, and other regional inspectors, as appropriate. Additional onsite inspection effort will be conducted to complete the scope of the inspection.

Questions regarding the objectives of this Special Inspection may be directed to Mr. John R. White, Chief, Division of Reactor Safety-Plant Support Branch 2 (610-337-5114).

Attachment: Special Inspection Team Charter - Indian Point Unit 2

Special Inspection Charter with Status Indicated in Italics

Special Inspection Charter
Indian Point Unit 2
Spent Fuel Pool Leak

The objectives of the inspection are to determine the facts and assess the conditions surrounding the Indian Point Unit 2 Spent Fuel Pool (SFP) leak identified in September 2005. Specifically the inspection should:

1. Develop a Sequence of Events associated with the Unit 2 spent fuel pool relative to its construction, previous history of leaks, pool modifications, and present leak identification and management activities.

   Sequence of Events completed through February 28, 2006, to include completion of Phase 1 monitoring wells. Refer to attachment 1 of this report.

2. Assess the adequacy of Entergy's determination of the source and cause of leakage, extent of condition review, operational experience usage, and corrective actions for the condition. Independently assess new information obtained during Entergy's investigation, including the discovery of tritium contamination in an onsite monitoring well on October 5, 2005.

   The identification of the source(s) of tritium groundwater contamination is still under investigation. No specific leak location in the Unit 2 SFP has been identified. Yet unexplained elevated tritium contamination has been identified in the Unit 3 transformer yard and additional tritium radioactivity has been collected in the Unit 1 groundwater collection system than is attributable to the known leakage from the Unit 1 SFP system. The initial identification of underground plant systems and structures containing potential contaminants has been completed. A root cause analysis consisting of a site hydrology study to trace the contaminants back to their source and a parallel plant evaluation and inspection of potential leaking components remains to be accomplished.

3. Evaluate Entergy's assessment of the risk significance of the condition, and evaluations of structural integrity and radiological impact.

   Structural integrity engineering analysis of the spent fuel pool has been reviewed, indicating negligible impact from the Unit 2 SFP cracks. A revised dose calculation based on multiple onsite groundwater tritium samples is being refined, currently estimated to result in 1.5E-5 mrem, per year based on current groundwater transport modeling. A final dose calculation will be provided after individual sources are identified and the site hydrology model is refined (late 2006).

4. Evaluate current mitigation strategy for the SFP leak.

   The capture and collection of Unit 2 SFP leakage has been completed. Onsite ground-water monitoring wells and storm drain tritium sampling indicate the potential for additional leaks that have yet to be identified.. Additional phase 2 wells remain to be installed followed by the performance of groundwater tracer studies. After tracer studies have confirmed the groundwater transport pathways, and the identification of leakage sources, the licensee's mitigation decisions regarding the feasability of repairing leaks or groundwater remediation activities will be made (Fall 2006).

5. Evaluate repair strategy and time line for the SFP leak.

   40% of the SFP liner welds have been examined, to date. Additional work is still planned with no firm time line established due to technical difficulties involved in performing underwater video inspections in areas with limited clearances. Continued spent fuel pool liner inspections are planned. No leaks have yet been identified. Other sources of onsite tritium leaks are also being investigated. Until sources of leakage can be identified there can be no repair strategy or timeline.

6. Evaluate the licensee's plans, both near-term and long-term, for assessing SFP liner integrity, including any relevant design considerations.

   Three monitoring wells have been installed adjacent to the U2 SFP, however, their efficacy in detecting SFP leakage will be established after the final site hydrology study is complete and the licensee establishes a monitoring well surveillance procedure (after September 2006).

7. Review the effectiveness of Entergy's efforts to monitor and control the water inventory used in the Unit 1 fuel and equipment storage pools.

   The licensee has effectively evaluated the water inventory loss from the Unit 1 spent fuel pool system. A mass balance review of tritium loss from the Unit 1 SFP system versus tritium collection in the associated Unit 1 groundwater collection system indicates that approximately seven times more tritium is being collected in the Unit 1groundwater collection system. This indicates that there may be additional tritium source(s) that require identification and mitigation, however, all of the tritium associated with the Unit 1 groundwater collection system has been appropriately monitored and released into the discharge canal as required.

8. Identify any issues requiring additional review for generic applicability.

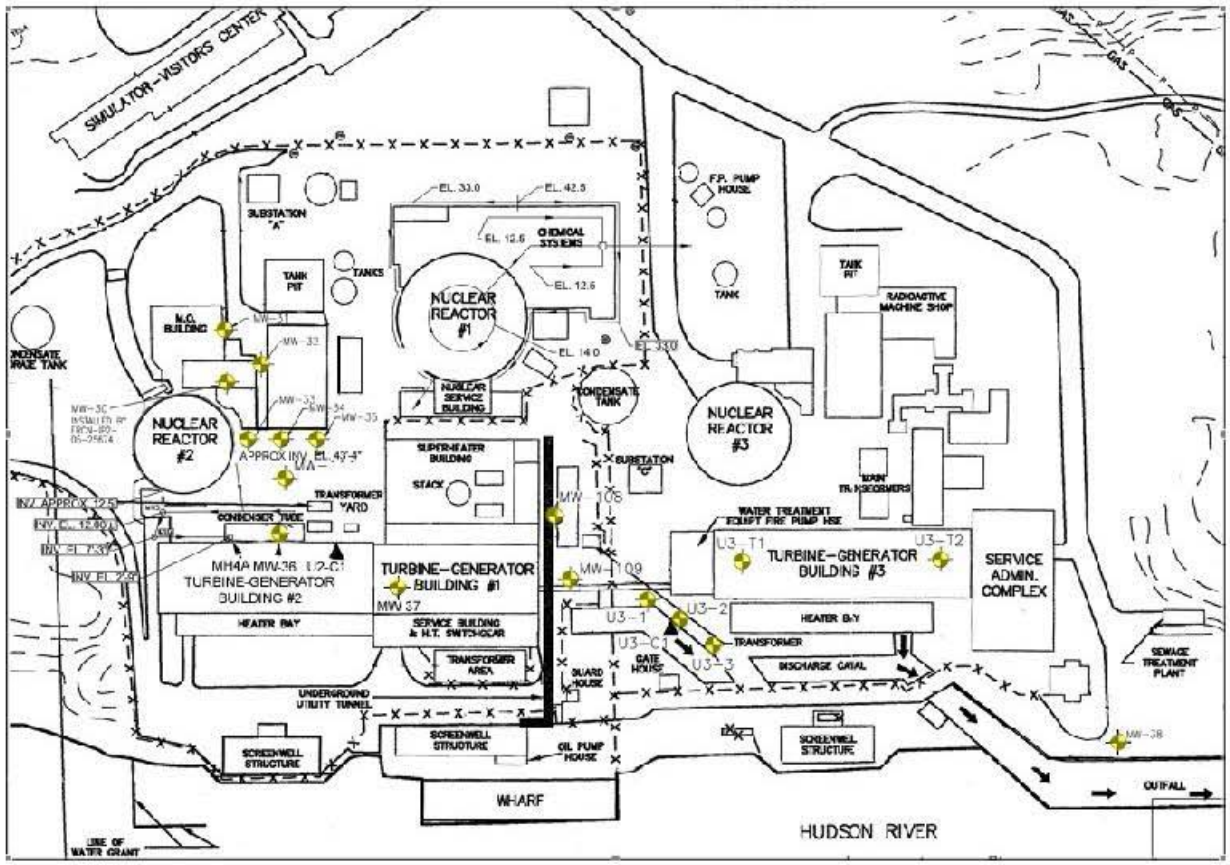
   Contamination of onsite groundwater due to leaking plant structures, systems or components is being reviewed by the NRC as a potential generic issue. Recent groundwater contamination events at various nuclear power plants have received considerable NRC attention. Although no adverse dose impacts have been identified related to these events, there is concern that under different circumstances than have occurred in cases thus far, undetected leakage to the onsite groundwater system can result in areas of groundwater contamination, undetected releases of radioactivity to the unrestricted area, and unevaluated doses to members of the public.

9. Document the inspection findings and conclusions in a special inspection report in accordance with Inspection Procedure 93812 within 45 days of the exit meeting for the inspection. Periodic updates will be provided as the inspection is ongoing.

   Documentation of Special Inspection Report no. 5000247/2005011 published prior to April 14, 2006, fulfills this requirement. Periodic updates both inside and outside the NRC were provided on a regular basis. Daily Region I NRR status meetings, bi-weekly congressional and New York State stakeholder teleconferences and regular postings on a "Plant-Specific Items of Interest" NRC web page listing provided periodic status of the inspection. Resolution of the licensee's onsite groundwater tritium investigation will be documented in another Special Inspection Report at the conclusion of the licensee's investigation.

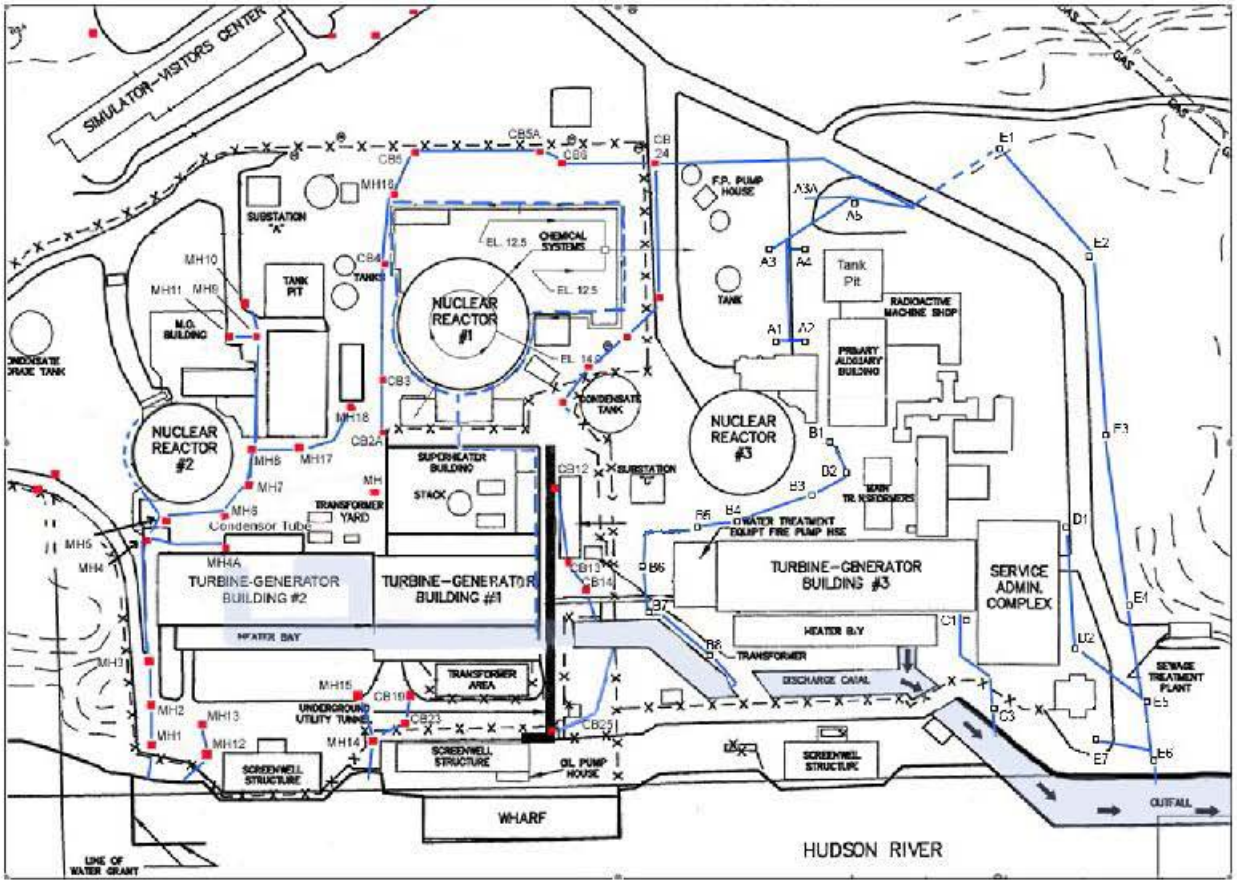
ATTACHMENT 7

Phase 1 Onsite Monitoring Wells



ATTACHMENT 8

Onsite Storm Drains



SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

W. Axelson	Radiation Protection Support Supervisor
M. Barvenik	Principal Engineer, GZA Geo Environmental, Inc.
J. Comiotes	Director, Nuclear Safety Assurance
P. Conroy	Manager, Licensing
D. Croulet	Licensing Engineer
F. Dacimo	Site Vice President
C. English	Unit 1 Project Engineer
D. Gately	Radiation Protection Superintendent
T. Jones	Licensing Engineer
R. LaVera	Radiological Engineer
D. Leach	Director, Entergy North East, Special Projects
D. Mayer	Director, Special Projects
P. Peloquin	Project Engineer
J. Peters	Plant Chemist
P. Rubin	Plant Manager
S. Sandike	Chemistry ODCM Specialist
G. Schwartz	ISFSI Project Manager
J. Skonieczny	Project Engineer

LIST OF INSPECTIONS PERFORMED

93812 Special Inspections

LIST OF DOCUMENTS REVIEWED

Consolidated Edison Calculation No. CGX-00006-00, “Seismic Qualification Structural Evaluation of the Unit 2 Fuel Pool Wall Considering Deteriorated Condition of Concrete Due to Pool Leak”

United Engineers and Constructors Technical Report No. 8281,”Evaluation of Spent Fuel Pool Walls - Indian Point 2 Nuclear Power Plant”

ABS Consulting Report 1487203-R-001, “Study of Potential Concrete Reinforcement Corrosion on the Structural integrity of the Spent Fuel Pit”, September 2005

Chazen, “Northern Westchester County groundwater conditions summary, data gaps and program recommendations”, Contract C-PL-02-71, Dutchess County Office, the Chazen Companies, Poughkeepsie, NY, April 2003.

Clark, J.F., P. Schosser, M. Stute, and H.J. Simpson, “SF_6 - ^3He tracer release experiment: A new method of determining longitudinal dispersion coefficients in large rivers”, *Environmental Science and Technology*, vol 30, pp 1527-1532, 1996.

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Freeze and Cherry, *Groundwater*, 1979

GWPO, “Groundwater Program Office annual report for fiscal year 1994, ORNL/GWPO-013.

NCRP, “Screening Models”, National Council on Radiation Protection and Measurements, report no. xxx, 1996.

Whitman, “Assessment of groundwater migration pathways from Unit 1 spent fuel pools at Indian Point Nuclear Power Plant”, the Whitman Companies Inc, Project 940510, July 1994.

ABS Consulting Report 1394669-R-004, Rev. C, “Assessment of Leakage from Unit 1 West Fuel Pool during Fuel Cleaning Activities”

ENN-DC-114, Rev. 2, “Unit 1 Remediation - Phase 1 Project Plan

USGS Open File Report 01-385, “Characterization of Fractures and Flow Zones in a Contaminated Shale of the Watervliet Arsenal, Albany County, NY”

Procedures

EN-LI-102, “Corrective Action Process”, Rev. 3
EN-LI-118, “Root Cause Analysis Process”, Rev. 3
EN-LI-119, “Apparent Cause Evaluation (ACE) Process”, Rev. 3
HP-SQ-3.013, Rev. 12, “Routine Surveys Outside the Normal RCA”
2-CY-2625, Rev. 3, “General Plant Systems Specifications and Frequencies”
3-CY-2325, Rev. 1, “Radioactive Sampling Schedule”

Condition Reports

IP2-2005-03885
IP2-2005-03557
IP2-2005-04151
IP2-2005-03986
IP2-2005-04152
IP2-2005-M-11
IP2-2005-04789
IP2-2005-04799
IP2-2005-04957
IP2-2005-04977
IP2-2005-05145
IP2-2005-05160
IP2-2005-05194
IP2-2006-00137
IP2-2006-00488

Drawings

9321-F-1196-7, Fuel Storage Building Concrete Details No. 1
9321-F-1197-8, Fuel Storage Building Concrete Details No. 2
9321-F-1198-8, Fuel Storage Building Concrete Details No. 3
9321-F-1199-7, Fuel Storage Building Concrete Details No. 4
9321-F-1200-5, Fuel Storage Building Concrete Details No. 5

9321-F-1388-15, Fuel Storage Building Floor Plans, Section & Roof
9321-F-1389-11, Fuel Storage Building - Building Elevations & Section
9321-F-1390-05, Fuel Storage Building - Building Details & Door Schedule
9321-F-2514-16, Fuel Storage General Arrangement Plans & Elevations (U2)
9321-F-2576-24, Fuel Storage Building Auxiliary Coolant System Plans
9321-F-2577-24, Fuel Storage Building Auxiliary Coolant System Sections
9321-F-2715-5, Containment Building Piping & Penetrations - Details of Fuel Transfer Tube
9321-F-2762-15, Fuel Storage Building Piping Supports

Miscellaneous

ENN-LI-101 Att. 9.1, 50.59 Screen Control Form Activity, ID No. DCP-03-2-128
IP2 FSAR, Section 1.2.1.2, “Geology and Hydrology” Rev. 19
IPEC Preliminary Cause Analysis, FSB Concrete Wall/Tritium in the Groundwater, February 10, 2006

LIST OF ACRONYMS

CFR	Code of Federal Regulations
CR	condition report
EPA	Environmental Protection Agency
ESSAP	Environmental Site Survey and Assessment Program
FSAR	final safety analysis report
FSB	Fuel Storage Building
GPM	gallons per minute
IN	Information Notice
IP	Inspection Procedure
IP2	Indian Point 2
IPEC	Indian Point Energy Center
IR	Inspection Report
ISFSI	independent spent fuel installation facility
K-T	Kepner-Tregoe
MDC	minimum detectable concentration
MSL	mean sea level
MW	monitoring well
NCD	north curtain drain
NYS DEC	State of New York Department of Environmental Conservation
NYSEMO	State of New York Emergency Management Organization
NYSPSC	State of New York Public Services Commission
ORISE	Oak Ridge Institute for Science and Education
PCB	polychlorinated biphenyls
REMP	Radiological Environmental Measurement Program
SFD	sphere foundation drain
SFP	spent fuel pool
SIT	special inspection team
SPDES	state pollution discharge elimination system
USGS	United States Geological Survey

Note: Explanation of the terms groundwater, ground-water and ground water -- Hydrologists often use the term “ground-water” in adjective form and “ground water” in noun form. This report has not followed that convention, and instead typicially uses “groundwater” universally. However, all three forms of the word may be used herein.