UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3)	)	Docket Nos. 50-247-LR and 50-286-LR

PREFILED WRITTEN TESTIMONY OF GILLIAN STEWART

REGARDING CONTENTION RK-EC-3/CW-EC-1 (SPENT FUEL POOL LEAKS)

On behalf of Riverkeeper, Inc. ("Riverkeeper"), Gillian Stewart submits the following testimony regarding Consolidated Contention RK-EC-3/CW-EC-1:

Q. Please state your name and address.

A. My name is Gillian Stewart and my business address is School of Earth and Environmental Sciences, Queens College, CUNY, 65-30 Kissena Blvd., Flushing, NY 11367

Q. What is your educational and professional background?

A. My undergraduate degree is in Biology Magna Cum Laude from Harvard University in 1997. My doctoral degree is from the School of Marine and Atmospheric Sciences (formerly Marine Sciences Research Center) at Stony Brook University in Coastal Oceanography (2005). The title of my thesis was "The Accumulation and Trophic Transfer of Polonium-210: Biogeochemical Implications." My thesis advisors were Dr. Nicholas Fisher, a marine radio-ecologist, and Dr. Kirk Cochran, a marine radio-geochemist. I performed much of my doctoral research at the IAEA Marine Laboratory in Monaco under the supervision of Dr. Scott Fowler, an aquatic radio-chemist and radio-ecologist.

Q. Can you please discuss your experience as it relates to fate, transport, and accumulation of radionuclides in aquatic systems.

A. Although my thesis work and subsequent research has primarily focused on natural (primordial, U-series) radionuclides, I have taken numerous courses in radiochemistry, radio-ecology, and marine pollution. I specifically study the grandmother/grand-daughter isotope pair of lead-210 and polonium-210. These isotopes each exhibit unique behavior in aquatic systems and act as model particle-reactive radiogenic isotopes. I have written over 18 papers on radio-isotope fractionation between the dissolved and particulate pool in aquatic systems, and have authored a book title called *Bioaccumulation of U/Th isotopes in marine organisms.* In addition to my work on isotopes, I have studied trace metal accumulation in multiple freshwater, estuarine, and marine systems including metal uptake by invertebrates of the Hudson River from resuspended sediments after simulated dredging.

I am a tenured professor of Environmental Science at Queens College and have taught graduate courses in Environmental Biogeochemistry, Marine Ecology, and Isotope Chemistry in Long Island Sound, along with multiple undergraduate courses in Earth and Environmental Science, Water Resources, and Oceanography.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide support for, and my views on, Riverkeeper and Clearwater's Consolidated Contention RK-EC-3/CW-EC-1. This contention was admitted by the Atomic Safety & Licensing Board ("ASLB") on July 31, 2008. Intervenors assert that Entergy Nuclear Operations, Inc. ("Entergy") and the U.S. Nuclear Regulatory Commission ("NRC") have failed to adequately address the environmental impacts of accidental radiological leaks at Indian Point, including a failure to sufficiently consider how such radionuclides impact the aquatic ecology of the Hudson River, and a failure to consider impacts related to a reasonably foreseeable drinking water pathway in light of a proposed desalination facility to be located in the direct vicinity of Indian Point.

Q. What materials have your reviewed in preparation for your expert report and testimony?

A. I reviewed Riverkeeper and Clearwater Consolidated Contention, NRC Staff's FSEIS, documentation related to United Water New York's proposed desalination project, several documents identified as relevant to the contention by Entergy.

Q. What conclusions have you reached about the impact of accidental radiological leaks at Indian Point on the Hudson River?

A. If there is present, past, or future leakage of radio-activity in the form of Sr-90, H-3, Cs-137 or other isotopes from Indian Point into the waterway of the Hudson River, even low activities of these materials will form a potential threat to the health of the local ecosystem via dissolved and particulate exposure. Current research indicates that there is a linear, no threshold response curve between human exposure to radioactivity and solid cancers. Further, there is evidence that multi-celled organisms exposed to low doses of radiation can develop mutations which are transmissible to offspring, indicating that leaks which happened in the past may still affect organisms that rely on the Hudson River for food or water today or in the future. The fact that Sr-90 has been found in fish tissue from the Hudson River and more than half of river water samples, indicates that strontium represents a potentially harmful contaminant, as it is a known carcinogen which accumulates in skeletal material and can cause bone and blood cancers. The dissolved phase of Sr-90 can travel long distances on the tidal river (both north and south of the source) and will most likely not be removed by traditional decontamination methods such as filtration, coagulation, and clarification. Cs-137 would be expected to behave similarly, but does not accumulate in organisms, making it more likely to travel long distances in the dissolved phase and be difficult to remove from the water column. Both Sr-90 and Cs-137 have half-lives of approximately 30 years and so can be expected to remain in the system for over 150 years or 5 half-lives. A careful study of the temporal and spatial distribution of these isotopes should be conducted before water from the Hudson River is considered safe for human consumption.

Q. Please describe your understanding of radiological leaks and groundwater contamination at Indian Point.

A. Based on my review of exhibits 33, 39, and 40 as well as the DEIS of the UWNY, it is my understanding that at certain times groundwater from Indian Point is or has been highly

contaminated with radioactive isotopes from previous and possible ongoing leaks from fuel pools and other sources, at levels exceeding state and federal drinking water standards. For the radiological samples (Table 2.4 in Chapter 2 of DEIS), the samples were collected at various locations throughout the Hudson River and not specifically at the outflow of the groundwater or near Indian Point. Despite this fact, many samples were positive for radioactivity. Even though average gross alpha and gross beta are below MCLs, some of the samples were higher than the MCL. Specifically, the maximum alpha acticity was 20pCi/L when the MCL is 15 pCi/L and the maximum beta activity detected was 62 pCi/L when the MCL was 50 pCi/L. This fact can also explain why the averages are relatively high (3.5 and 10.8 pCi/L respectively), even though samples below detection were averaged as "zero" in the calculation. These high ranges of radioactivity detected are likely due to leaks or flows via groundwater effluent into the Hudson River.

Further, although the levels are low, Sr-90 was detected in more than half of the Hudson River water samples. Therefore, more sampling needs to be done (both a time-series to verify temporal variability and a transect to the North, South, and West to verify spatial variability) in the area directly adjacent to Indian Point and to the intake location of the Proposed Project in Haverstraw Bay. As far as Uranium, the indication is that it was found in all samples at low levels.

It appears undisputed that contamination in the groundwater migrates to the Hudson River; Entergy has chosen to employ Monitored Natural Attenuation. This is not a satisfactory approach because the long half-lives of the radionuclides involved (approximately 30 years for the isotopes of Sr and Cs) mean this contamination released into the Hudson River through the groundwater will pose a threat to the water quality of the river throughout the entire period of extended operations of the proposed project in Haverstraw Bay, and requires more study before it can be allowed to decay without treatment. Generally, radio-chemists use a very optimistic benchmark of 5 half-lives to determine the residence time of isotopes in a system. With this in mind, the Cs-137 and Sr-90 will be in the vicinity of Indian Point (and tidal waters north and south) for at least 150 years. Further, new or continuous leaks would add new radio-isotopes to the water column and thus would not contribute to natural attenuation.

Q. What is understood about the pathways for fate and transport of this contamination?

A. The fate of radio-isotopes depends on the phase it is in: dissolved or particulate. Both Cs and Sr are slightly particle reactive, generally on the order of 1000 times more concentrated on particles than in the dissolved phase (IAEA TRS 190, 1976: Effects of ionizing radiation on aquatic organisms and ecosystems). However, using the partition coefficients, K_ds, this still results in the majority of the isotope to be found in the dissolved phase. In most cases, the particulate phase is more dense than water and settles to the bottom of the water column or gets ingested by organisms. The dissolved phase, on the other hand, can travel for long distances just as the water in the river is constantly being flushed by the flood and ebb of the tide. The residence time of the radio-isotopes in various locations of the River would be determined by the flushing time of the water in that region and not by the radiological decay of the isotopes.

Another relevant influence on radioisotope distributions in river-estuarine systems is suspended-sediment concentration. The activity of isotopes would tend to be lower in the presence of high suspended-sediment concentrations (Benoit and Rozan,1999). The Hudson River is a highly turbid environment and thus there would be many opportunities for the isotopes to sorb to particle surfaces and be removed from the dissolved phase. However, in the Hudson there has been extensive dredging, most recently associated with PCB clean-up. This has the potential to resuspend isotopes sorbed to sediments and re-introduce them into the water column and ecosystem.

Once Sr-90 gets into organisms, it replaces calcium in bone due to their similar chemical nature. This prevents the effective removal of the isotope from the body and strontium can accumulate over time with low level chronic exposure. Cesium, on the other hand, forms a chloride compound in the body and is water-soluble, thus is effectively flushed from organisms through urine or sweat. Thus, while Cs-137 will not accumulate through food chains via trophic transfer, there is a high potential that Sr-90 will. Humans could thus be exposed to Sr-90 at low levels by drinking river water contaminated with the isotope, or by the consumption of fish which have accumulated Sr-90 throughout their lifetimes.

Q. The Hudson River is a tidal estuary as far north as the Federal Dam in Troy and south into New York Harbor. How far will the radioactive isotopes leaking from Indian Point travel?

A. Because Sr-90 and Cs-137 are primarily found in the dissolved phase, they will travel with the river water as far as the local water travels. According to the hydrological surveys, the groundwater enters the river at depth. This will affect the distance the water travels since the salty water travels more slowly up the bottom of the river than the freshwater travels seaward along the river surface. Either way, there is nothing stopping the isotopes from travelling with a parcel of river water.

However, while they travel, the parcel of water is being diluted by other river water and so the concentration will decrease over time due to dilution. The rate of dilution will be faster than the rate of radioactive decay, so this will limit the activity of the isotopes as they travel, but not the distance they can travel. The only thing that would limit the distance traveled is adsorption onto particles or uptake into organisms.

Q. The NRC Staff stated in its FSEIS concerning the proposed license renewal of Indian Point that "there is no drinking water exposure pathway to humans that is affected by the contaminated groundwater conditions at the IP2 and IP3 site."[1] How would you respond to this statement?

A. While that may currently be the case, it is my understanding that there is a proposed project for a desalinization plant to be sited 5 miles downstream of Indian Point by United Water New York, called Haverstraw Long-Term Water Supply Project. While the initial pilot project is removing 144,000 gallons per day (at a rate of 100 gallons per minute to deliver approximately 100,000 gpd of potable water), the final completed plant would withdraw 10 million gallons of water per day from the Hudson, which would yield 7.5 mgd of drinking water for Rockland County residents.[2] As I understand, this project is currently in permitting phase; it is reasonably foreseeable that it will come to fruition. This will result in water from the Hudson River right

[1] Indian Point FSEIS at 2-111.
[2] Haverstraw Water Supply Project DEIS, Draft EIS, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/uwnyfnlscope.pdf (Exhibit RIV000101); Pilot Study: http://haverstrawwatersupplyproject.com/project-facts/pilot-study.html

near Indian Point being used for a drinking water source at some point during the proposed extended operating terms.

Q. Please summarize your opinions about the impact of accidental radiological leaks at Indian Point on the Hudson River.

A. In summary, I believe that Sr-90 and Cs-137 that are leaking into the Hudson River via groundwater from the Indian Point Nuclear Facility pose a clear and imminent threat to both the ecosystem of the Hudson River as well as potential contaminants for the desalinization plant proposed by UWNY in Haverstraw Bay. Because of the long half-lives of these isotopes and their ability to travel long distances in the dissolved phase, they will easily be able to travel the five miles to the intake point for the drinking water project. Low levels of exposure to these radionuclides via drinking water or contaminated seafood have the potential to cause cancer in humans. More sampling needs to be done to determine the extent of radiological contamination in both time and space. The Sr-90, H-3, and Cs-137 leaks will need to be stopped and some decontamination efforts will need to be taken before the water in the Hudson near Indian Point is consistently safe for human consumption.

Q. Does this conclude your initial testimony regarding Consolidated Contention RK-EC-3/CW-EC-1?

A. Yes.

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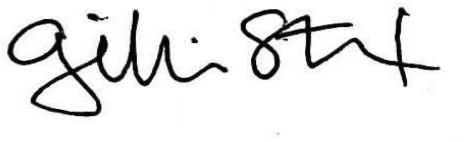
DECLARATION OF GILLIAN STEWART

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

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



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