


United States Nuclear Regulatory Commission Official Hearing Exhibit	
In the Matter of:	Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3)
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

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

1 **Q. Please state your name and address.**

2 A. My name is Gillian Stewart and my business address is School of Earth and
3 Environmental Sciences, Queens College, CUNY, 65-30 Kissena Blvd., Flushing, NY 11367
4

5 **Q. What is your educational and professional background?**

6 A. My undergraduate degree is in Biology Magna Cum Laude from Harvard University in
7 1997. My doctoral degree is from the School of Marine and Atmospheric Sciences (formerly
8 Marine Sciences Research Center) at Stony Brook University in Coastal Oceanography (2005).
9 The title of my thesis was “The Accumulation and Trophic Transfer of Polonium-210:
10 Biogeochemical Implications.” My thesis advisors were Dr. Nicholas Fisher, a marine radio-
11 ecologist, and Dr. Kirk Cochran, a marine radio-geochemist. I performed much of my doctoral
12 research at the IAEA Marine Laboratory in Monaco under the supervision of Dr. Scott Fowler,
13 an aquatic radio-chemist and radio-ecologist.

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

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

13

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

18

19 **Q. What is the purpose of your testimony?**

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

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1 **Q. What materials have you reviewed in preparation for your expert report and**
2 **testimony?**

3 A. I reviewed Riverkeeper and Clearwater Consolidated Contention, NRC Staff's FSEIS,
4 documentation related to United Water New York's proposed desalination project, several
5 documents identified as relevant to the contention by Entergy.
6

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

9 A. If there is present, past, or future leakage of radio-activity in the form of Sr-90, H-3, Cs-
10 137 or other isotopes from Indian Point into the waterway of the Hudson River, even low
11 activities of these materials will form a potential threat to the health of the local ecosystem via
12 dissolved and particulate exposure. Current research indicates that there is a linear, no threshold
13 response curve between human exposure to radioactivity and solid cancers. Further, there is
14 evidence that multi-celled organisms exposed to low doses of radiation can develop mutations
15 which are transmissible to offspring, indicating that leaks which happened in the past may still
16 affect organisms that rely on the Hudson River for food or water today or in the future. The fact
17 that Sr-90 has been found in fish tissue from the Hudson River and more than half of river water
18 samples, indicates that strontium represents a potentially harmful contaminant, as it is a known
19 carcinogen which accumulates in skeletal material and can cause bone and blood cancers. The
20 dissolved phase of Sr-90 can travel long distances on the tidal river (both north and south of the
21 source) and will most likely not be removed by traditional decontamination methods such as
22 filtration, coagulation, and clarification. Cs-137 would be expected to behave similarly, but does
23 not accumulate in organisms, making it more likely to travel long distances in the dissolved
24 phase and be difficult to remove from the water column. Both Sr-90 and Cs-137 have half-lives
25 of approximately 30 years and so can be expected to remain in the system for over 150 years or 5
26 half-lives. A careful study of the temporal and spatial distribution of these isotopes should be
27 conducted before water from the Hudson River is considered safe for human consumption.
28

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

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

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

13

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

19

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

31

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

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

13

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

22

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

31

1

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

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

11

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

17

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

22 A. While that may currently be the case, it is my understanding that there is a proposed
23 project for a desalinization plant to be sited 5 miles downstream of Indian Point by United Water
24 New York, called Haverstraw Long-Term Water Supply Project. While the initial pilot project is
25 removing 144,000 gallons per day (at a rate of 100 gallons per minute to deliver approximately
26 100,000 gpd of potable water), the final completed plant would withdraw 10 million gallons of
27 water per day from the Hudson, which would yield 7.5 mgd of drinking water for Rockland
28 County residents.² As I understand, this project is currently in permitting phase; it is reasonably
29 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/uwnyfnscope.pdf (Exhibit RIV000101); Pilot Study:
<http://haverstrawwatersupplyproject.com/project-facts/pilot-study.html>

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

3

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

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

17

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

20 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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