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ADJUDICATIONS STAFF

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of:

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

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

STATEMENT OF DR. RICHARD T. LAHEY, JR.

MARCH 9, 2012

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STATEMENT OF DR. RICHARD T. LAHEY, JR.

I, Richard T. Lahey, Jr., state as follows:

1. I am currently the *Edward E. Hood Professor Emeritus of Engineering* at Rensselaer Polytechnic Institute (RPI) in Troy, New York. I hold the following academic degrees: a B.S. in Marine Engineering from the United States Merchant Marine Academy, a M.S. in Mechanical Engineering from RPI, a M.E. in Engineering Mechanics from Columbia University, and a PhD. in Mechanical Engineering from Stanford University. At RPI, I have served as both the Dean of Engineering and the Chairman of the Department of Nuclear Engineering & Science. In addition, I have been the lead engineer and manager of various departments responsible for safety analyses, heat transfer mechanisms, and core & safety development for the General Electric Company (GE), including both military (*i.e.,* Naval) and commercial nuclear reactors.

2. I am a member of various professional societies, including: the American Nuclear Society (ANS), where I was a member of the Board of Directors, and the ANS's executive committee, and was the founding Chair of the ANSs' Thermal-Hydraulics Division; the American Society of Mechanical Engineers (ASME), where I was Chair of the Nucleonics Heat Transfer Committee, K-13; the American Institute of Chemical Engineering (AIChE), where I was the Chair of the Energy Transport Field Committee; and the American Society of Engineering Educators (ASEE), where I was Chair of the

Nuclear Engineering Division. I have also been an editor of *Nuclear Engineering & Design*, and international journal devoted to fission energy. I am a member of the National Academy of Engineering (NAE), and have been elected Fellow of both the ANS and the ASME.

3. Moreover, I have received numerous honors and awards for my career accomplishments, including: the ANS's Seaborg Medal and Compton Award, the U.S. Department of Energy's E.O. Lawrence Memorial Award, and the AIChE's Donald Q. Kern Award. Over the last 40 years, I have published numerous books, monographs, chapters, articles, studies, reports, and journal papers on nuclear engineering and nuclear reactor safety technology, and most of these publications have been peer reviewed.

4. In addition, I have served on numerous panels and committees for the United States Nuclear Regulatory Commission (USNRC), Idaho National Engineering Laboratory (INEL), Oak Ridge National Laboratory (ORNL), and the Electric Power Research Institute (EPRI). I served as a member of a committee that conducted a study under the auspices of the National Research Council (NRC) of the National Academy of Sciences (NAS) to review the safety and security of spent nuclear fuel storage (discussed in more detail below).

5. My *Curricula Vitae*, which more fully describes my educational and professional background and qualifications, is available at: http://www.rpi.edu/~laheyr/laheyvita.html.

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

7. The Indian Point power reactors and spent fuel pools are 5 miles west of the New Croton Reservoir in Westchester County. They are also approximately 24 miles north of New York City, 35 miles from Times Square, 38 miles from Wall Street, 5 miles northeast of Haverstraw, 16 miles southeast of Newburgh, 17 miles northwest of White Plains, 23 miles northwest of Greenwich, 37 miles west of Bridgeport, and 37-39 miles north northeast of Jersey City and Newark.

8. Having received their initial operating licenses in 1973 and 1975, the Indian Point facilities are close to the end of their initial 40-year license terms. The facilities are currently in the midst of a proceeding concerning their application to the USNRC for permission to operate for an additional 20 years. I have reviewed the license renewal application and the Final Safety Analysis Reports (FSAR) that were submitted by Entergy Nuclear Operations, Inc. (Entergy) for the two operating Indian Point nuclear reactors, spent fuel pools, and associated systems. These plants are known as Indian Point Unit 2 (IP2) and Indian Point Unit 3 (IP3). I have also reviewed additional documents referred to below.

9. In my opinion, and as I explain more fully below, there are some important concerns associated with spent fuel storage pools at these plants that urgently need to be addressed, including the vulnerabilities of these spent fuel storage pools to natural disasters, sabotage, and fires.

10. Even after it is used in nuclear reactors to generate energy, spent nuclear fuel remains extremely radioactive. To protect workers, facilities, and neighboring communities, most nuclear power plants have constructed large swimming-pool-like structures in which the spent fuel was to be stored temporarily until it cooled sufficiently to allow its transfer to a reprocessing facility or disposal site in the United States (*e.g.*, West Valley (NY), Yucca Mountain (NV)). Because no reprocessing facility or final disposal site is operational, the spent fuel has remained for decades in these temporary storage pools and some of the spent nuclear fuel has subsequently been transferred from the pools to associated dry cask storage facilities. Unfortunately, the storage pools are susceptible to fire and radiological releases in the event the pools drain and the fuel becomes partially or completely uncovered.

11. Like other power reactors in the United States, the two operating Indian Point reactors have spent fuel pools located outside their containment buildings that contain significant quantities of radioactive material. At Indian Point, the spent fuel pools are within the fuel services buildings (FSBs).

12. It should be noted that nuclear emergencies associated with inadequately cooled spent fuel pools are not currently addressed by USNRC's Severe Accident Mitigation Alternatives (or SAMA) analyses and environmental review for the renewal of operating licenses conducted pursuant to the National Environmental Policy Act (or NEPA). In addition, a detailed probabilistic risk assessment (PRA) of spent fuel storage pools has not been done, and the USNRC has implicitly assumed that a station blackout, a loss of both offsite electrical power and onsite emergency power, will be corrected within 48 hours. Moreover, virtually all of the procedures to mitigate radiation releases to the environment from a stricken nuclear site are associated with relatively short-term releases. Those assumptions are dramatically different from the extended station blackouts and radiation releases that occurred at the nuclear power reactor plants at the Fukushima Daiichi site in Japan.

13. The recent nuclear emergency at the Fukushima Daiichi nuclear facilities in Japan has focused world-wide attention on severe accidents at nuclear power plants. In particular, the consequences of the release to the environment of significant quantities of radiation from inadequately cooled nuclear reactor cores and spent fuel storage pools (both of which depend on the availability of electrical power for that cooling) have been graphically demonstrated.

14. While all the details of what took place during this disaster in Japan have yet to be determined, it is clear that spent fuel storage pools are potentially a significant source for radiation releases to the environment. Furthermore, according to USNRC documents and statements, it appears that the spent fuel pools at Fukushima Daiichi Unit 3 and Unit 4 contained less spent fuel assemblies than the spent fuel pools for Indian Point Unit 2 and Unit 3. Moreover, since the proximity of the Indian Point plants to the major population center of New York City (24 miles) is much closer than the proximity of Fukushima Daiichi to Tokyo (~150 miles), it is clear that the spent fuel storage pools at Indian Point present important environmental and safety concerns, with the potential for major environmental damage.

15. The Indian Point facilities are susceptible to a wide range of natural disasters, including: earthquakes; hurricanes; lightning strikes; tornados; and fires. In particular, tornados have recently resulted in the loss of offsite power and the shutdown of a number of nuclear power plants in the South (*e.g.*, within TVA) and the Midwest. Indeed, a very strong tornado (*e.g.,* Category 5, with wind speeds > 200 mph) has the potential to significantly damage the relatively weak fuel service buildings housing the spent fuel storage pools at Indian Point, and it could also result in a loss of water from the pools, uncovering the spent fuel. If so, significant fuel heat up and radiation releases to the environment may occur.

16. While some have concluded that, unlike at Fukushima, a major tsunami at the Indian Point site is not likely, it should be noted that Indian Point has experienced internal flooding events.[1]

17. Also, other factors specific to the Indian Point spent fuel pools increase the relative risk of accidents occurring. For example, the packing density of the spent fuel pools at Indian Point is several times (*i.e.*, > 5) larger than the density that the pools were originally designed for and, thus, it is more difficult to maintain adequate cooling during emergency events.

18. The following charts summarize how USNRC has authorized increasing amounts of spent nuclear fuel to be stored in the spent fuel pools for Indian Point Unit 2 and Unit 3:

IP2 SPENT FUEL POOL STORAGE LIMITS[2]	
Date	Fuel Assemblies
1973	264
1980	482
1985	980
1989	1,376

IP3 SPENT FUEL POOL STORAGE LIMITS[3]	
Date	Fuel Assemblies
1975	264
1978	840
1989	1,345

[1] *See* USNRC Information Notice No. 80-37, Containment Cooler Leaks and Reactor Cavity Flooding at Indian Point Unit 2 (ML031180421).
[2] *Source*: Consolidated Edison, *Final Design Report for Reracking the Indian Point Unit No. 2 Spent Fuel Pool,* at 1, ML100200292 (May 1980); Consolidated Edison, *Supplemental Spent Fuel Safety Analysis,* at 3-1, ML100350310 (Nov. 1985); and Consolidated Edison, *Indian Point Unit 2 Spent Fuel Pool Increased Storage Capacity Licensing Report,* at 1-2, ML100200114 (June 1989).
[3] *Source*: USAEC, Safety Evaluation Report by the Directorate of Licensing U.S. AEC In the Matter of Consolidated Edison Co. of New York, Inc. Indian Point Nuclear Generating Unit No. 3, at 4-1, 9-2, ML072260465 (Sept. 21, 1973); USNRC, Indian Point, Unit 3, Amendment 13, Authorizing Modifications to the Spent Fuel Pool, Increasing Capacity from 264 to 840 Fuel Assemblies, attached to Letter from A. Schwencer, NRC to New York State Power Authority, ML003778668 (Mar. 22, 1978); and USNRC, Indian Point, Unit 3, Amendment 90, Allowing for the Expansion of the Spent Fuel Pool Storage Capacity, attached to Letter from Joseph Neighbors, NRC to New York Power Authority, ML003778816 (Oct. 12, 1989).

19. In fact, the USNRC recently has expressed significant concern about the possibility of having an uncontrolled recriticality in densely packed pools due to uncertainties about fuel/poison burnup and related mechanical changes, both of which factors affect reactivity, and due to the age-related degradation of the Boron-based neutron absorbers used in densely packed spent fuel pools.[4] If a recriticality were to occur, it could lead to the release of massive amounts of radiation from the fuel stored in the pools.

20. Additionally, NUREG/CR-1429 (1980) indicates that both IP-2 and IP-3 were designed for a safe shutdown earthquake (SSE) ground acceleration of 0.15g horizontal and 0.10g vertical. It is significant that the ground accelerations experienced by the North Ana reactors in Virginia (which recently experienced a 5.9 Richter Scale earthquake) produced ground accelerations more than three (3) times this level, which appears to be why the reactors remained shut down for a number of months following the earthquake. Considerably more attention needs to be paid to the seismic design capabilities of the Indian Point reactors and spent fuel pools to ensure that adequate cooling is maintained.

21. Clearly the risks posed by the dense storage of spent fuel, and the consequences of a natural disaster (*e.g.*, an F5 tornado) or a sabotage attack on the spent fuel pools at the Indian Point nuclear power plants are

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[4] *See* USNRC, On Site Spent Fuel Criticality Analyses, NRR Action Plan (Sept. 19, 2011) (ML11251A210).

very important issues, since they has the potential for major harm to the environment. Significantly, this issue is not addressed by the USNRC's severe accident mitigation alternatives (SAMA) analysis and the reviews of environmental impacts under the National Environmental Policy Act. The SAMA analysis examines severe *reactor* accidents, but not severe *spent fuel pool* accidents. A natural disaster or a sabotage/terrorist attack on the spent fuel pools may result in radiation releases that could cause significant adverse environmental and health effects and property damage in one of the most populated areas of the country – the New York City metropolitan area.

22. I served as a member of a Committee that conducted a study under the auspices of the National Research Council (NRC) of the National Academy of Sciences (NAS) to review the safety and security of spent nuclear fuel storage. This committee was called the "Committee on the Safety and Security of Commercial Spent Nuclear Fuel Storage of the Board of Radioactive Waste Management," and it reported directly to the United States Congress. In 2005, the National Research Council published a public version of its report of the Committee's findings, which I co-authored. The public report, "*Safety and Security of Commercial Spent Nuclear Fuel Storage*," is available to the public and the USNRC [National Research Council of the National Academies, Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report, International Standard Book Number 0-309-09647-2, Library of Congress Control Number 2005926244 (copyright

2006) (hereinafter the "NAS Study")].[5] (In addition, I understand that the National Research Council's confidential report may also be made available to those with appropriate security clearances and "need to know.") In any event, as discussed in the public NAS Study, my colleagues on the National Research Council Committee and I studied various possible terrorist attack and sabotage scenarios, and we concluded that spent fuel pools, such as those at Indian Point, are indeed vulnerable to such attacks.

23. Regarding the consequences of sabotage attacks on a nuclear power reactors, the USNRC's 1996 Generic EIS states that "if such events were to occur, the commission would expect that the resultant core damage and radiological release would be no worse than those expected from internally initiated events" [*See* USNRC's Generic Environmental Impact Statement (NUREG-1437, Vol. 1) (May 1996), § 5.3.3.1 (Review of Existing Impact Assessments)]. The 1996 Generic EIS conclusion may be true for a terrorist attack on or within the primary containment of these nuclear reactors, but it is most certainly <u>not</u> true for a terrorist attack on the two operational spent fuel pools at Indian Point. Indeed, far more radioactivity is present in the spent fuel located in the two operational spent fuel storage pools at Indian Point than there is in the active core of the two operating nuclear reactors.

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[5] The NAS Study also is available through the NRC's public ADAMS system within accession number ML11297A091. *See also* NRC Statement No. 05-061 (Apr. 6, 2005).

24. It is important to note that spent fuel pools are not enclosed by a leak-tight containment structure. Rather, they are surrounded by only a confinement building, which is not a leak-tight containment structure. Thus, if a natural disaster or terrorist attack leads to sufficient pool drainage or coolant evaporation and a propagating zirconium fire, much of the radioactive inventory in the spent fuel could be released to the environment. The resulting plume of radiation released into the atmosphere can result in significant adverse environmental and health effects and property damage in and around the Indian Point plants, including New York City (NYC), and the immediate portions of northern New Jersey and southwestern Connecticut. More than seventeen million people reside or work within a fifty-mile radius of Indian Point, so a timely evacuation would be impossible. Significantly, the surrounding population is projected to grow over the next 20 years. At risk, too, are trillions of dollars of property in the tri-state region and, of course, the financial capital of the world (NYC) could be contaminated with radiation, and seriously disrupted.

25. The 2005 public NAS Study made several recommendations for mitigation, including moving older spent fuel into dry cask storage, rearrangement of the spent fuel that is required to be in the storage pools, and the installment of a seismically-qualified spray cooling system. *See, e.g.,* NAS Study, Chapters 3 & 4. At that time, USNRC did not accept these recommendations.

26. Recently, the Tennessee Valley Authority announced that it was considering moving spent nuclear fuel from the spent fuel pools at its reactors to dry storage casks.[6]

27. I also understand that the USNRC is in the process of revisiting its previous position concerning the installation of seismically-qualified spray cooling systems in spent fuel storage pools.

28. Entergy has not indicated in its relicensing application that it has adopted these mitigation measures for any of the spent fuel pools at Indian Point. Although Entergy is apparently moving some of its spent fuel from the Indian Point spent fuel pools to dry cask storage, this is to ensure that IP3 has the ability to remove the entire inventory of nuclear fuel inside the reactor core (*i.e.,* a full core offload).[7] In any event, this proposal will not mitigate the threat outlined above since more-recently discharged spent nuclear fuel is both the most highly radioactive fuel and generates the most decay heat, and thus must remain in the spent fuel pools until it is adequately cooled (about five years).[8] Rather, Entergy should accelerate the

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[6] Tennessee Valley Authority, "Fact Sheet: Nuclear Program Update" (April 14, 2011), http://www.tva.gov/news/releases/aprjun11/pdf/nuclear_program-update_fact_sheet.pdf.

[7] The ability to remove the entire core of nuclear fuel from the reactor core and transfer it to a spent fuel pool, known as a "full core off load," is generally recognized as a basic precondition to the operation of a power reactor.

[8] Entergy is running out of space in the Indian Point Unit 3 spent fuel pool – even with the allowance for dense storage configuration – and if spent nuclear fuel is not removed it will not be able to accomplish a full core off load. *See* Entergy communication NL-09-076 to USNRC, Application for Unit 2 Operating License Condition Change and Units 2 and 3 Technical Specification Changes to Add Inter-

removal of older spent nuclear fuel that currently resides in the densely packed IP3 and IP2 spent fuel pools and the placement of that fuel in dry casks. In addition, the two active reactors will continually generate more spent fuel during the proposed twenty year license renewal period, and because of its decay heat and radioactivity, this spent fuel must remain in the spent fuel pools for some time before it can be moved to dry cask storage (*i.e.*, the natural convective cooling by air in dry cask storage can not keep this fuel cool enough).

29. Finally, given the proximity of these plants to New York City, the potential health, environmental, real estate, and financial impacts are very significant – much more so than at any other nuclear power plant in the nation. Thus, I believe it is vital that Entergy, the USNRC Staff, and USNRC Commissioners consider all reasonable severe accident mitigation alternatives (SAMA) concerning natural disasters and terrorist attacks on the spent fuel pools. USNRC should allow interested States or local governments to raise alternatives to the continuation of dense storage of spent fuel in spent fuel pools as part of the license renewal process for a given reactor on a site-specific basis.

Unit Spent Fuel Transfer Requirements, ML091940177 ("Approval of these changes is needed to restore and maintain full core off load capability in the Unit 3 spent fuel pit for the remainder of its service life and to allow for periodic receipt of new fuel in support of future refueling outages.").

Conclusion

30. In summary, the continued dense storage of spent nuclear fuel in the Indian Point Unit 2 and Unit 3 spent fuel pools pose significant environmental risks that need to be addressed and mitigation alternatives need to be explored. To date, unfortunately, Entergy and the USNRC have glossed over many of these issues, to the extent that they have addressed them at all. Unfortunately, the environmental impact of the release of a significant amount of radiation from the spent fuel storage pools at Indian Point could be catastrophic, and, thus, the examination of readily available mitigation alternatives for these spent fuel storage pools must have a very high priority before USNRC authorizes them for the period of extended commercial operation.

R. T. Lahey

Dr. Richard T. Lahey, Jr. March 9, 2012

REFERENCES

1. USAEC, *Safety Evaluation Report by the Directorate of Licensing U.S. AEC In the Matter of Consolidated Edison Co. of New York, Inc. Indian Point Nuclear Generating Unit No. 3* (Sept. 21, 1973) (ML072260465).

2. USNRC, *Indian Point, Unit 3, Amendment 13, Authorizing Modifications to the Spent Fuel Pool, Increasing Capacity from 264 to 840 Fuel Assemblies*, attached to *Letter from A. Schwencer, NRC to New York State Power Authority* (Mar. 22, 1978) (ML003778668).

3. Consolidated Edison, *Final Design Report for Reracking the Indian Point Unit No. 2 Spent Fuel Pool,* Docket No. 50-247 (May 1980) (ML100200292).

4. Consolidated Edison, Supplemental Spent Fuel Safety Analysis, 3-1 (Nov. 1985) (ML100350310).

5. Consolidated Edison, *Indian Point Unit 2 Spent Fuel Pool Increased Storage Capacity Licensing Report* (June 1989) (ML100200114).

6. USNRC, *Indian Point, Unit 3, Amendment 90, Allowing for the Expansion of the Spent Fuel Pool Storage Capacity*, attached to *Letter from Joseph Neighbors, NRC to New York Power Authority* (Oct. 12, 1989) (ML100200114).

7. USNRC, *On Site Spent Fuel Criticality Analyses, NRR Action Plan* (Sept. 19, 2011) (ML11251A210).

Rulemaking Comments

From: John J. Sipos [John.Sipos@ag.ny.gov]
Sent: Friday, March 09, 2012 3:02 PM
To: NRCExecSec Resource; Rulemaking Comments
Subject: Re: RIN 3150–AI42; Docket ID: NRC–2008–0608; 10 CFR Part 51
Attachments: 2012 03 09 RTL Stmt.pdf

Re: RIN 3150-AI42; Docket ID: NRC-2008-0608; 10 CFR Part 51 & GEIS for License Renewal

Dear Secretary Vietti-Cook and Rulemaking Staff:

Attached please a statement by Dr. Richard Lahey concerning the above-referenced rulemaking.

Please contact me if you are unable to locate any of the referenced documents.

Respectfully submitted,

John Sipos
State of New York

Date: March 9, 2012