UNITED STATES
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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In re:	Docket Nos. 50-247-LR; 50-286-LR
License Renewal Application Submitted by	ASLBP No. 07-858-03-LR-BD01
Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Operations, Inc.	DPR-26, DPR-64 September 9, 2015
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STATE OF NEW YORK AND RIVERKEEPER, INC. SUPPLEMENTAL REPLY STATEMENT OF POSITION CONSOLIDATED CONTENTION NYS-26B/RK-TC-1B

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PRELIMINARY STATEMENT

In accordance with 10 C.F.R. § 2.1207, July 1, 2010 Scheduling Order[1] of the Atomic Safety and Licensing Board ("Board"), the Board's December 9, 2014 Revised Scheduling Order,[2] and the Board's May 27, 2015 Order,[3] the State of New York (the "State") and Riverkeeper, Inc. (collectively, "Intervenors") hereby submit their Reply Statement of Position on the admitted Consolidated Contention NYS-26B/RK-TC-1B, concerning the management of fatigue at the Indian Point nuclear facilities.

Contrary to conclusions reached in the Statements of Position and Prefiled Testimony submitted by Entergy and NRC Staff, Entergy does not have an adequate plan to manage the effects of fatigue on aging and embrittled components at IP2 and IP3. [redacted] Considering the many possible sources of error and non-conservatism identified by Intervernors' experts, there is a real risk that components will suffer fatigue-induced failures before their calculated CUF_{en} values reach 1.0. In light of Entergy's failure to present an adequate fatigue management program, its license renewal application (LRA) for IP2 and IP3 should be denied.

[1] *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Scheduling Order (July 1, 2010) (unpublished) (ML101820387).

[2] *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Revised Scheduling Order (December 9, 2014) (unpublished) (ML14343A757).

[3] *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Order (Granting New York's Motion for an Eight-Day Extension of the Filing Deadline) (May 27, 2015) (unpublished) (ML15147A567). The May 27, 2015 Order extended the deadline for the State and Riverkeeper to file their revised prefiled testimony, affidavits and exhibits from June 1, 2015 to June 9, 2015, and shifted all subsequent filing deadlines forward by eight days. *Id.*

BACKGROUND

The background and procedural history of Consolidated Contention NYS-26B/RK-TC-1B are set forth fully in Intervenors' June 9, 2015 Revised Statement of Position (Exh. NYS000529, at 5-17), which was supported by the Revised Prefiled Testimony of Dr. Richard Lahey in Support of Contention NYS-25 (Exh. NYS000530), the Revised Prefiled Testimony and Supplemental Report of Dr. Joram Hopenfeld (Exhs. RIV000142, RIV000144), and numerous supporting exhibits. In response, Entergy and NRC Staff submitted statements of position (Exhs. ENT000678 and NRCR20101), prefiled testimony (Exhs. ENT000679 and NRC000168) and other exhibits.[4] Although [redacted] NRC Staff argue that Consolidated Contention NYS-26B/RK-TC-1B should be resolved in favor of the applicant, they have failed to address many of the issues raised by Intervenors and their experts.

LEGAL STANDARDS

The applicable legal standards have been previously briefed by the State. *See* NYS Revised SOP on NYS-28B/RK-TC-1B, at 17-19 (Exh. NYS000529). Intervenors reiterate that in order to obtain a license renewal of IP2 and IP3, Entergy must establish that "the effects of aging on the intended function(s)" of important safety components "will be adequately managed for the period of extended operation." 10 C.F.R. § 54.21(c)(1)(iii). The various guidance documents relied upon by [redacted] NRC Staff, however, are "routine agency policy pronouncements that do not carry the binding effect of regulation." *International Uranium (USA) Corp.* (Request for Materials License Amendment), CLI-00-1, 51 N.R.C. 9, 19 (2000).

[4] Notably, Entergy submitted only a non-public version of its Statement of Position and Prefiled Testimony, both of which were designated as proprietary in their entirety. On August 31, 2015, the State requested that Entergy submit public redacted versions of its Statement of Position and Prefiled Testimony, in order to permit public participation in the upcoming November 2015 evidentiary hearing on Consolidated Contention NYS-26B/RK-TC-1B. On September 3, 2015, counsel for Entergy indicated that they would submit redacted versions of the documents within two weeks.

ARGUMENT

As demonstrated by the Reply Testimony of Dr. Richard Lahey and responsive report by Dr. Joram Hopenfeld, [redacted] NRC Staff have failed to address Intervenors' concerns over the possible failure of highly-fatigued components. Contrary to the insistence by NRC Staff [redacted] that the parties can trust Westinghouse to conduct conservative environmentally assisted fatigue (EAF) calculations, Dr. Lahey and Dr. Hopenfeld have identified numerous sources of error and non-conservatism in the EAF calculations. [redacted] Accordingly, Entergy has failed to establish that that it has an adequate plan to manage the effects of aging on key reactor components and its LRA cannot be granted pursuant to 10 C.F.R §§ 54.21(a)(3), 54.21(c)(1)(iii), and 54.29(a).

I. Reply Testimony of Dr. Richard Lahey

Dr. Lahey's Reply Prefiled Testimony (Exh. NYS000569) ("Lahey Reply PFT") highlights several issues that Entergy and NRC Staff have overlooked. First, Dr. Lahey reiterates that the effects of irradiation embrittlement on component fatigue life must be considered in EAF calculations. Lahey Reply PFT, at 6-8. Contrary to the testimony of [redacted] NRC Staff's witnesses, embrittlement can reduce the number of fatigue cycles that a component can withstand prior to failure, especially if the component is subjected to large amplitude, low cycle fatigue. Lahey Reply PFT, at 7-8; Kanaski, et al., "Fatigue and Stress Corrosion Cracking Behaviors of Irradiated Stainless Steels in PWR Primary Water," ICONE-5, at 2372 (May 1997) (Exh. NYS000177); Arai, et al., "Irradiation Embrittlement of PWR

Internals," Proceedings ASME/JSME 2d International Nuclear Engineering Conference, Vol. 2, at 103 (1993) (Exh. NYS000564); Korth, G.E. & Harper, M.D., "Effects of Neutron Radiation on the Fatigue and Creep/Fatigue Behavior of Type 308 Stainless Steel Weld Materials at Elevated Temperatures," Proceedings of the 7th International Symposium on the Effects of Raditation on Structural Materials, Gatlinburg, TN (June 1974) (Exh. RIV000152). [redacted] NRC Staff recognize that cracks will propagate more rapidly in embrittled metals. [redacted] NRC Staff PFT on NYS-25, at A192, A193 (Exh. NRC000197). Additionally, embrittled and fatigue-weakened structures may not tolerate seismic and shock loads like new, fully ductile structures. Lahey Reply PFT, at 8. Accordingly, the failure to factor embrittlement effects into EAF calculations creates a real risk that components will fail before their CUF_{en} value reaches 1.0.

[redacted]

[redacted] NRC Staff approves of this process, while conceding that "[g]iven the variability in assumptions made by different analysts, it is difficult to explicitly quantify the exact overall safety margin present in fatigue calculations." NRC Staff PFT on NYS-26B/RK-TC-1B, at A210 (NRC000168). [redacted].[5]

Dr. Lahey describes a variety of specific concerns with the use of the proprietary WESTEMS™ software program to calculate CUF_{en} values, which could result in non-conservatise CUF_{en} results. Lahey Reply PFT, at 27-28. [redacted]

[5] Additionally, all of the calculation notes containing CUF_{en} output values and the process used by Westinghouse to calculate CUF_{en} values have been designated as "proprietary" and are not available, in whole or in part, for public review. The Board recently rejected the State's attempt to obtain disclosure of portions of four specific calculation notes. *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Order (Denying New York Motion to Withdraw Proprietary Designation) (July 20, 2015) (unpublished) (ML15201A488).

Dr. Lahey then highlights the continuing need for a "propagation of error" or uncertainty analysis regarding the results of the EAF calculations. Lahey Reply PFT, at 4-5, 23-24. [redacted] NRC Staff claim that an evaluation of the potential errors or uncertainties inherent in the EAF calculations is not required, because the CUF_{en} results are "determinative" and "conservative." [redacted] NRC Staff PFT on NYS-26B/RK-TC-1B, at A171 (NRC000168). However, as described above, the amount of conservatism remaining in the EAF calculations after Westinghouse has removed "unnecessary" conservatism has not been quantified. Lahey Reply PFT, at 22-23; *see* NRC Staff PFT on NYS-26B/RK-TC-1B, at A210 (Exh. NRC000168). [redacted] If the uncertainty exceeds the conservatism, then the result of any EAF calculation could be non-conservative. [redacted]

Dr. Lahey prepared a chart to illustrate how increased fatigue in RVI components impacts the possibility of fatigue failure, as well as the effects of fatigue on embrittled and non-embrittled components. *See* Comparison of Limit Line (LL) and Best Estimate (BE), Figure 1, *infra* (Exh. NYS000566). Dr. Lahey describes this figure in detail in his Reply Testimony, at 8-17. Figure 1 shows time and fluence on the x-axis, and CUF_{en} on the y-axis. The graph plots two possible

CUF_{en} calculations for a hypothetical component: (1) a "limit line" showing the supposed bounding and conservative EAF calculation [redacted]; and (2) a "best estimate" line showing a possible EAF calculation that would attempt to accurately predict fatigue life for the component. Additionally, the "best estimate" line depicts an EAF calculation that does not consider embrittlement (BE_{ne}) as well as an EAF calculation that does consider embrittlement (BE_e). Lastly, the best estimate line depicts a delta range (Δ) to represent the uncertainty in the EAF calculation.

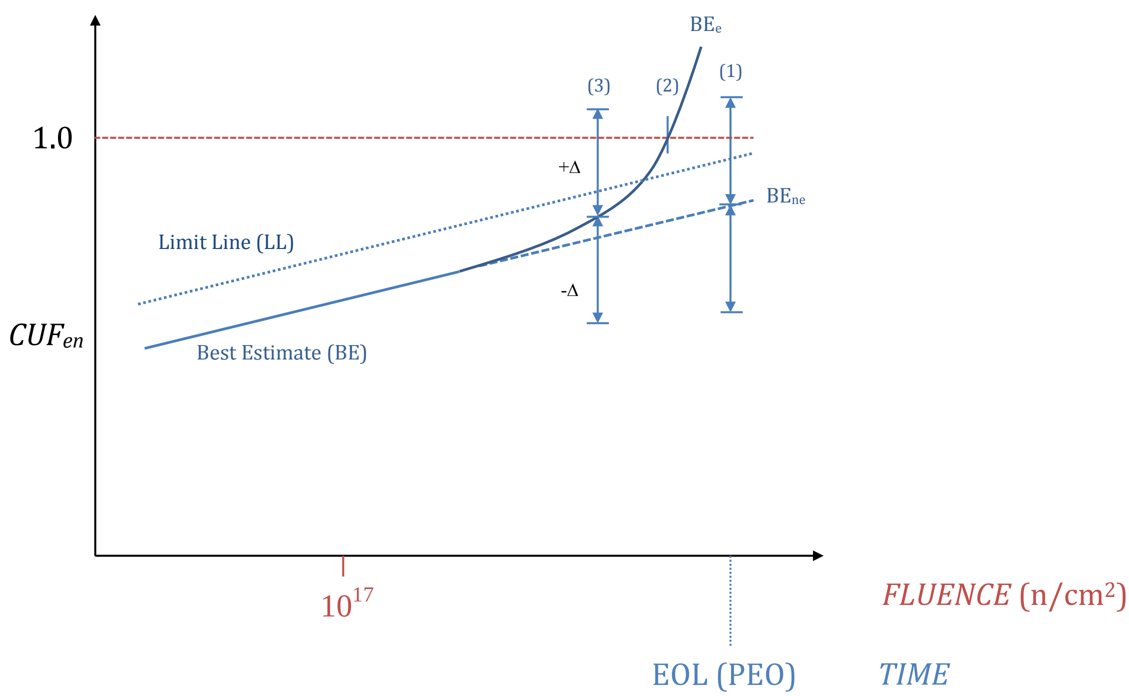

Figure 1: Comparison of Limit Line (LL) and Best Estimate (BE) predictions, with embrittlement (BE_e) and without embrittlement (BE_{ne}) (Exh. NYS000566).

Note:
(1) BE_{ne} predicts possible failure at end of life (EOL).
(2) BE_e predicts failure (CUF_{en} = 1.0) before end of life.
(3) BE_e predicts possible failure well before end of life.

Although the "limit line" is above the "best estimate" line (i.e., predicts a higher CUF_{en} value) through most of the component's life, the uncertainty bar shows that the actual CUF_{en}

value may exceed the limit line – that is, the uncertainty may be greater than the conservatism in the calculation. The chart also depicts three locations where cracking and component failure may occur. At location 1, the best estimate line that does not account for embrittlement may exceed 1.0 towards the end of the plant's period of extended operation (PEO), due to uncertainty in the CUF_{en} output. This is true even though the supposedly conservative limit line is still below 1.0. At location 2, the best estimate line that considers embrittlement exceeds 1.0 late in the component's life, but well before the end of the PEO. This reflects the fact that embrittlement may reduce the number of fatigue cycles to failure, especially as the component is subjected to fluence greater than 10^{17} n/cm^2. Finally, location 3 shows that when embrittlement and uncertainty are factored into the best estimate line, the component may fail long before the end of the PEO. Notably, [redacted] it is impossible to determine whether uncertainty is greater than conservatism, or when the combined effects of embrittlement and uncertainty may cause a component's CUF_{en} to exceed 1.0. Lahey Reply Testimony, at 16-17.

Dr. Lahey also observes how several statements from [redacted] NRC Staff actually support his concerns regarding the failure to consider synergistic aging effects and the impact of accident loads on components with very high CUF_{en} values. Lahey Reply PFT, at 6, 17-18. For example, he notes the "silo" thinking inherent in the NRC Staff's statement that "CUF or CUF_{en} analyses are not required for safety assessments of DBA events . . . because CUF and CUF_{en}, which are indicators of possible fatigue crack initiation, are not a significant contributor to safety during DBA events." NRC Staff PFT on NYS-26B/RK-TC-1B, at A171 (NRC000168). He notes that this approach ignores the reality of a reactor environment, where multiple aging mechanisms act simultaneously on RVIs and other components, which could then fail when subjected to a DBA or other shock load. Lahey Reply PFT, at 17-18. [redacted] He notes that fatigued and embrittled components may operate normally during steady-state operations, but fail suddenly and catastrophically when subjected to an accident load. Lahey Reply PFT, at 18-19.

[redacted] the accumulators uses the same nozzle as the residual hear removal (RHR) system and the low pressure coolant injection (LPCI) and intermediate pressure coolant injection (IPCI) safety systems. *See* NRC, Reactor Concepts Manual –PWR Systems Manual, at 4-25 (Exh NYS000563); Figure 2, *infra*. If the nozzle were to fail as a result of unaccounted for uncertainty in the EAF calculation or an unexpected seismic event or shock load, the result could be a LOCA event in which the accumulator, LPCI and IPCI systems would not be able to inject water into the cold leg and then into the core, resulting in a core meltdown. Lahey Reply PFT, at 29-30.

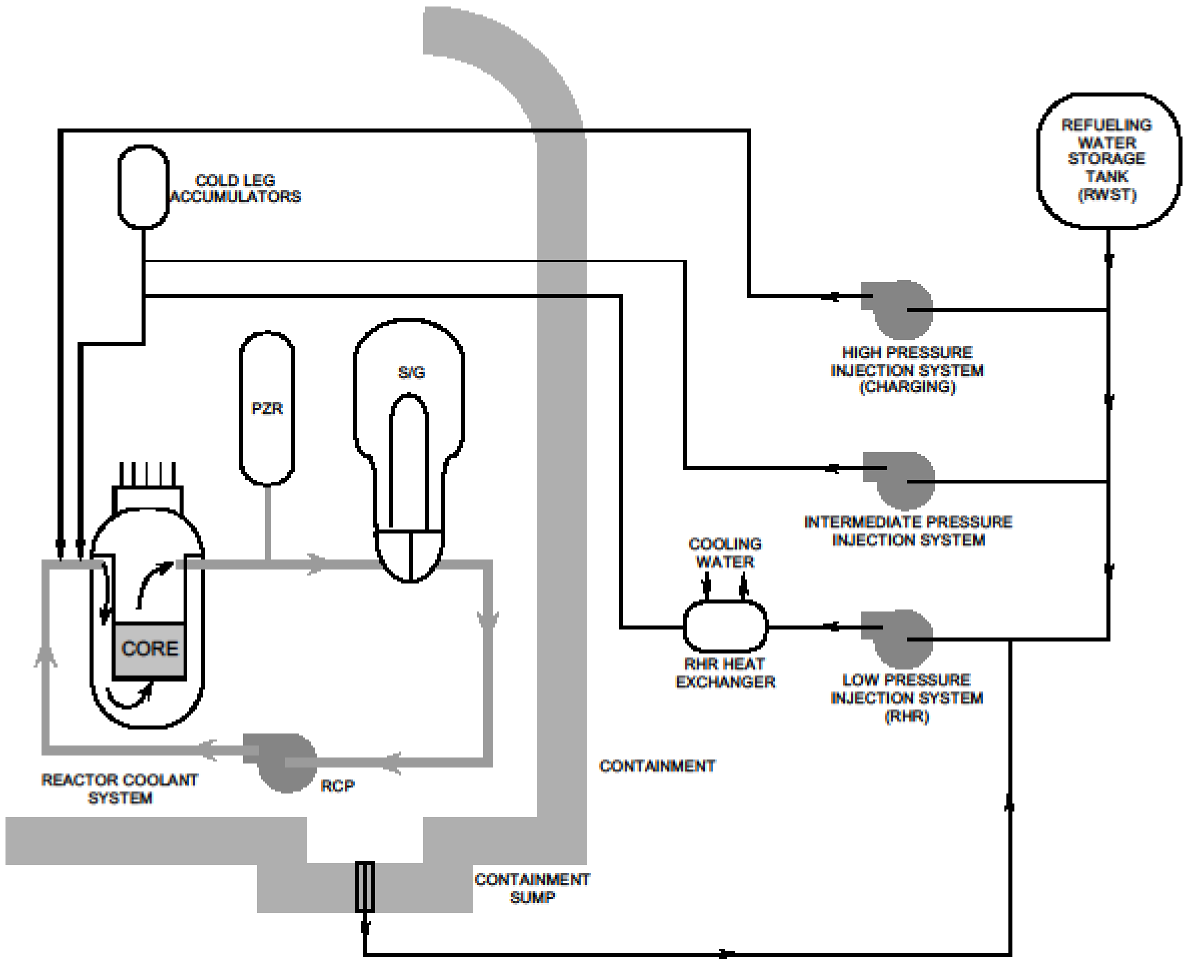

Figure 2. Emergency Core Cooling Systems. Source: NRC, Reactor Concepts Manual –PWR Systems Manual, at 4-25 (Exh NYS000563).

[redacted]

[redacted] NRC Staff indicated that if transients accumulate "at a rate greater than the rate assumed in the fatigue calculation," Entergy would be permitted to conduct yet another "more refined analysis." NRC Staff PFT on NYS-26B/RK-TC-1B, at A106 (Exh. NRC000168). In short, there is apparently no limit to the number of times CUF_{en} can be recalculated to obtain a result less than 1.0, and there is no standard for the amount of conservatism that must be retained in the calculation.

II. <u>Reply Testimony and Report of Dr. Joram Hopenfeld</u>

Dr. Joram Hopenfeld also submits a response to Entergy's and NRC Staff's testimony, identifying various omissions and deficiencies in their testimony.[6] [redacted]

[6] Riverkeeper has elected not to submit a public, redacted version of Dr. Hopenfeld's Responsive Report until Entergy submits public, redacted versions of its submissions. The State intends to file an updated public version of this document when that occurs.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

CONCLUSION

For the reasons set forth above, Entergy and NRC Staff have failed to establish that Entergy has an adequate plan to manage the aging effects of fatigue on critical reactor safety components at IP2 and IP3. Accordingly, Entergy's LRA should be denied.

Respectfully submitted,

Dated: September 9, 2015

Signed (electronically) by:

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