UNITED STATES
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

STATE OF NEW YORK
SUPPLEMENTAL REPLY STATEMENT OF POSITION
CONTENTION NYS-25

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TABLE OF CONTENTS

TABLE OF FIGURES AND TABLES

PRELIMINARY STATEMENT

In accordance with 10 C.F.R. § 2.1207, the Atomic Safety and Licensing Board's ("Board") July 1, 2010 Scheduling Order,[1] 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") hereby submits its Supplemental Reply Statement of Position on the State's admitted Contention 25 ("NYS-25"), as supplemented on September 15, 2010 and February 13, 2015, concerning the integrity of Indian Point's embrittled reactor pressure vessels and their internal components.

Entergy and NRC Staff have not addressed the State's concerns that Entergy has failed to submit an adequate plan to manage the effects of aging on reactor vessel internals (RVIs), as required by 10 C.F.R. § 54.29(a)(1). The Revised and Amended RVI Plan developed by Entergy and approved by NRC Staff in the Supplement 2 to the "Safety Evaluation Report Related to License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3" (SSER2) (Exh. NYS000507) is an "inspections-only" program that does not account for the effects of embrittlement or other aging mechanisms that may weaken components prior to the development of detectable degradation. Indeed, in the face of significant uncertainty regarding the combined effects of multiple degradation mechanisms acting on the RVIs, Entergy and NRC Staff propose

[1] *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Scheduling Order (July 1, 2010) (unpublished) (ML101820387).

[2] *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Revised Scheduling Order (December 9, 2014) (unpublished) (ML14343A757).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Units 2 and 3), Order (Granting New York's Motion for an Eight-Day Extension of the Filing Deadline) (May 27, 2015) (unpublished) (ML15147A567).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.*

to continue operating IP2 and IP3 as usual, waiting to act until components degrade and fail. The testimony and statements of position submitted by Entergy and NRC Staff illustrate the "silo" thinking and failure to consider aging effects and accident conditions together that first prompted the State's concerns in NYS-25. Considering the possibly catastrophic effects of the failure and relocation of RVIs within IP2 or IP3, this approach to aging management is irresponsible and inadequate as a matter of law.

BACKGROUND

The background and procedural history of Contention NYS-25 are set forth fully in the State's June 9, 2015 Revised Statement of Position (Exh. NYS000481, at 2-16), which was supported by the Revised Prefiled Testimony of Dr. Richard Lahey in Support of Contention NYS-25 ("Lahey Revised Testimony") (Exh. NYS000482), as well as numerous exhibits. In response, Entergy and NRC Staff submitted statements of position (Exhs. ENT000615 and NRC000196), prefiled testimony (Exhs. ENT000616 and NRC000197),[4] and various supporting exhibits, arguing that Contention NYS-25 should be resolved in favor of the applicant.[5] These submissions fail to address the State's concerns, or demonstrate that Entergy has an adequate plan to manage the effects of aging on RVIs. Accordingly, Contention NYS-25 should be resolved in the State's favor.

[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 versions of its Statement of Position and Prefiled Testimony, in order to permit public participation in the upcoming November 2015 evidentiary hearing on Contention NYS-25. On September 3, 2015, counsel for Entergy indicated that they would submit redacted versions of the documents within two weeks.

[5] On September 4, 2015, Entergy filed a "revised" version of its SOP on Contention NYS-25.

LEGAL STANDARDS

The applicable legal standards have been previously briefed by the State. *See* NYS Revised SOP on NYS-25, at 16-17, 29-30 (Exh. NYS000481). [redacted] However, NRC NUREGs, Regulatory Guides and other Guidance Documents 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). Ultimately, Entergy is required to show, among other things, that "there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the [current licensing basis] … [including] managing the effects of aging during the period of extended operation on the functionality of structures and components" such as RVIs. 10 C.F.R. § 54.29(a)(1); *see id.* § 54.21(a), (c). The State, with the aid of the Reply Prefiled Testimony of Dr. Richard Lahey (Exh. NYS000567) ("Lahey Reply PFT"), shows that Entergy has not met this regulatory standard.

ARGUMENT

Entergy and NRC Staff have failed to rebut the State's evidence that the applicant does not have an adequate aging management plan for reactor vessel internals. The Revised and Amended RVI Plan is an inspection-only plan that does not and cannot detect or account for the effects of irradiation embrittlement. *See* Attachment 1 to NL-12-037, at 5 (Exh. NYS000496) ("The Reactor Vessel Internals Program is a condition monitoring program that does not include preventative actions."); MRP-227-A, at 3-23, Table 3-3, note 1 (Exh. NRC000114A-F) ("There are no recommendations for inspection to determine embrittlement level because these mechanisms cannot be directly observed."). Even if cracks are detected during inspections,

preventative repair or replacement will not necessarily occur – rather, the inspection results will be routed through a corrective action program that may lead to more inspections or more detailed analysis. *See* [redacted] NRC Staff PFT on NYS-25, at A71 (Exh. NRC000197). [redacted] NRC Staff [redacted] acknowledge that neutron embrittlement can cause fractures to propagate more rapidly, [redacted] NRC Staff PFT on NYS-25, at A192-A193 (Exh. NRC000197), and yet [redacted] NRC Staff are seemingly content with an aging management plan that ignores aging effects that cannot be directly observed by inspection, such as embrittlement, and that permits continued plant operation even after embrittled components exhibit detectable signs of cracking and other degradation.

[redacted] NRC Staff also use the uncertainty surrounding the severity of synergistic aging degradation mechanisms as an opportunity to claim that some effects might actually be beneficial to the RVIs, or at the very least to prop up their belief that such synergy can be safely ignored. [redacted] NRC Staff's witnesses, at least, are more reserved in their description of the interaction between fatigue and irradiation embrittlement, noting that although they "agree that embrittlement may have an effect

on the fatigue properties of the stainless steel material, because embrittlement changes the mechanical properties of the material" the results of studies of the interaction are "inconclusive[.]" NRC Staff PFT on NYS-25, at A195, A196, A200 (Exh. NRC000197). Indeed, Dr. Lahey has testified and referred to supporting materials to show that although irradiation embrittlement might increase fatigue life in certain situations, in other situations it decreases the component's fatigue life and reduces the number of fatigue cycles to failure. *See* Lahey Reply PFT, at 4, 7-8; NUREG/CR-6909, Rev. 1, Draft, "Effects of LWR Coolant Environments on the Fatigue Life of Reactor Materials," at 11 (March 2014) (Exh. NYS000490A); Kanaski, et al., "Fatigue and Stress Corrosion Cracking Behaviors of Irradiated Stainless Steels in PWR Primary Water," ICONE-5, at 2372 (May 1997) (Exh. NRC000177); 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 Radiation on Structural Materials, Gatlinburg, TN (June 1974) (Exh. RIV000152).

[redacted] However, these reports are not even NRC-approved guidance documents, let alone binding NRC regulations. These reports were not presented to NRC as part of Entergy's LRA. As the State has noted, the documents governing aging management of RVIs at IP2 and IP3 are those encompassed in the Revised and Amended RVI Plan. NYS Revised SOP

on NYS-25, at 19 (NYS000481). [redacted]

However, Dr. Lahey has reiterated in his reply testimony that the documents underlying MRP-227-A do not alter his opinion on the inadequacy of the Revised and Amended RVI Plan. Lahey Reply PFT, at 5-6. The RVI Plan does not address the possibility that fatigued and embrittled components could have no visible signs of degradation, but could nonetheless fail when subjected to a sudden shock load. *Id.* at 6. [redacted] Supplementary industry reports, no matter how voluminous, cannot transform the inspection-only approach of the Revised and Amended RVI Plan into an adequate aging management plan under 10 C.F.R. § 54.29.

Several statements by [redacted] NRC Staff's witnesses highlight the State's concerns that Entergy has failed to consider the interactions of various aging mechanisms and the possible effects of accident shock loads. [redacted] all of the components in and around the clevis insert bolts are undergoing a range of aging mechanisms which may affect their functionality or their ability to withstand a sudden shock load. Lahey Reply PFT, at 20. [redacted]

[redacted]

[redacted] NRC Staff are generally unconcerned with the possibility that baffle former bolts or clevis insert bolts will fail, claiming that IP2 and IP3 could safely operate even if a "significant portion" of baffle former bolts or clevis insert bolts had failed. [redacted] NRC Staff PFT on NYS-25, at A295 (Exh. NRC000197). This approach is irresponsible – although the plant might function properly during steady state operations when a large percentage of in-core bolting has failed, a large shock load could cause the remaining bolts to suddenly fail, resulting in the relocation of core components and the loss of a coolable core geometry. Lahey Reply PFT, at 20-21. Similarly, NRC Staff's witnesses testified that aging mechanisms acting on the support columns are "properly assessed from the normal, steady-state operating conditions." NRC Staff PFT on NYS-25, at A306 (Exh. NRC000197). This approach does not account for seismic or LOCA-type shock loads, which could cause the columns to fail. Lahey Reply PFT, at 28.

[redacted]

The testimony of [redacted] NRC Staff's witnesses further highlights certain shortcomings in the fatigue evaluations for RVIs. Under Commitment 49, Entergy has agreed to conduct environmentally assisted fatigue (EAF) calculations for RVI components, and take corrective actions if the results (CUF_{en}) exceed 1.0. SSER2, at A-15 (NYS000507). [redacted] NRC Staff argue that no propagation of error or uncertainty analysis is required for environmentally assisted fatigue (EAF) calculations for RVI components, claiming that EAF evaluations conducted by Westinghouse are determinative and conservative. NRC PFT on NYS-26B/RK-TC-1B, at A171 (Exh. NRC000168); [redacted] Indeed, NRC Staff concedes 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 PFT on NYS-26B/RK-TC-1B, at A210 (Exh. NRC000168). Without this information, it is impossible to determine whether the level of conservatism remaining in the EAF calculations is greater than the uncertainty inherent in the calculation. If the uncertainty exceeds the conservatism, then the CUF_{en} values may be higher than those calculated by Entergy. For some RVIs with CUF_{en} values very close to 1.0, this could result in the component failing before the CUF_{en} reaches 1.0. Lahey Reply PFT, at 14-17. [redacted]

Component	Original CUF_{en}	CUF_{en} After Conservatisms Removed
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 1. Non-exclusive List of RVI Components with CUF_{en} Values Close to 1.0 Even After Conservatisms Have Been Removed. **Source:** CN-PAFM-13-32, Revision 3, at 19-30 (Exh. ENT000683).

Notably, [redacted] NRC Staff's major justification for ignoring the synergistic effects of irradiation embrittlement and fatigue is that embrittlement is only relevant in the presence of pre-existing fractures, and that such fractures will not occur until CUF_{en} exceeds 1.0. NRC Staff PFT on NYS-25, at A203, A207 (Exh. NRC000197); [redacted] Moreover, when the uncertainties and non-conservatisms are factored into the CUF_{en} calculations for components that are very close to 1.0, there is an even greater risk of cracking occurring before CUF_{en} reaches 1.0. Lahey Reply PFT, at 12-13. Once cracking occurs, even [redacted] NRC Staff agree that neutron embrittlement will increase the speed with which the cracks propagate, potentially leading to component failure.

The testimony of [redacted] NRC Staff's witnesses also ignores research results from the Expanded Materials Degradation Assessment (EMDA) and Light Water Reactor Sustainability (LWRS) research projects, on the grounds that those research projects only relate

to license extensions beyond 60 years of operation. *See* [redacted] NRC Staff PFT on NYS-25, at A 176, A178 (Exh. NRC000197). However, the results of these research projects in materials degradation are relevant to any extended operation of nuclear plants. Lahey Reply PFT, at 3. Indeed, EMDA Volume 2 is called "Aging of Core Internals and Piping Systems" and states, in the first sentence of the "Introduction" that, "[e]nsuring safe operation of NPPs for a first, and any subsequent, license renewal period (i.e., 60 – 80+ years) will require in-depth knowledge of the various modes of materials degradation that could impact the long-lived systems, structures, and components (SCC) of concern." NUREG/CR-7153, "Expanded Materials Degradation Assessment (EMDA), Volume 2: Aging of Core Internals and Piping Systems," at 1 (Oct. 2014) (NYS000484A). Among many other conclusions relevant to issues in this proceeding, EMDA has identified significant knowledge gaps in scientific understanding of irradiation-assisted aging phenomena. EMDA researchers ranked aging degradation phenomena based on the extent of current knowledge and susceptibility of structures, systems and components, and concluded that "irradiation-induced phenomena dominate" degradation mechanisms classified as "low Knowledge, high Susceptibility," which "indicate[s] gaps in understandings and are areas requiring research into mechanisms and underlying causes to predict occurrence." *Id.* at 209-211. These conclusions are undeniably relevant to the question of whether nuclear facilities such as IP2 and IP3 should be licensed beyond 40 years.

Likewise, the LWRS study makes clear that the aging degradation mechanisms it evaluates are relevant to the extended operation of nuclear power plants beyond 40 years. "Light Water Reactor Sustainability Program: Materials Aging and Degradation Technical Program," Rev. 2, at 1 (August 2014) (Exh. NYS000485) ("Ensuring public safety and environmental

protection is a prerequisite to all nuclear power plant operating and licensing decisions at all stages of reactor life. This includes the original license period of 40 years, the first license extension to 60 years, and certainly for any consideration of life beyond 60 years."). Like the EMDA researchers, the LWRS discovered significant knowledge gaps in scientific understanding of irradiation-assisted aging degradation mechanisms. LWRS conducted a poll of technical experts in materials degradation asking them which "modes of degradation they felt were the most problematic for long-term reactor operation[,]" and discovered that "[a]lmost every participant identified potential embrittlement of RPV steels and IASCC [Irradiation Assisted Stress Corrosion Cracking] of core internals as a key concern." *Id.* at 10; *see* Figure 1.

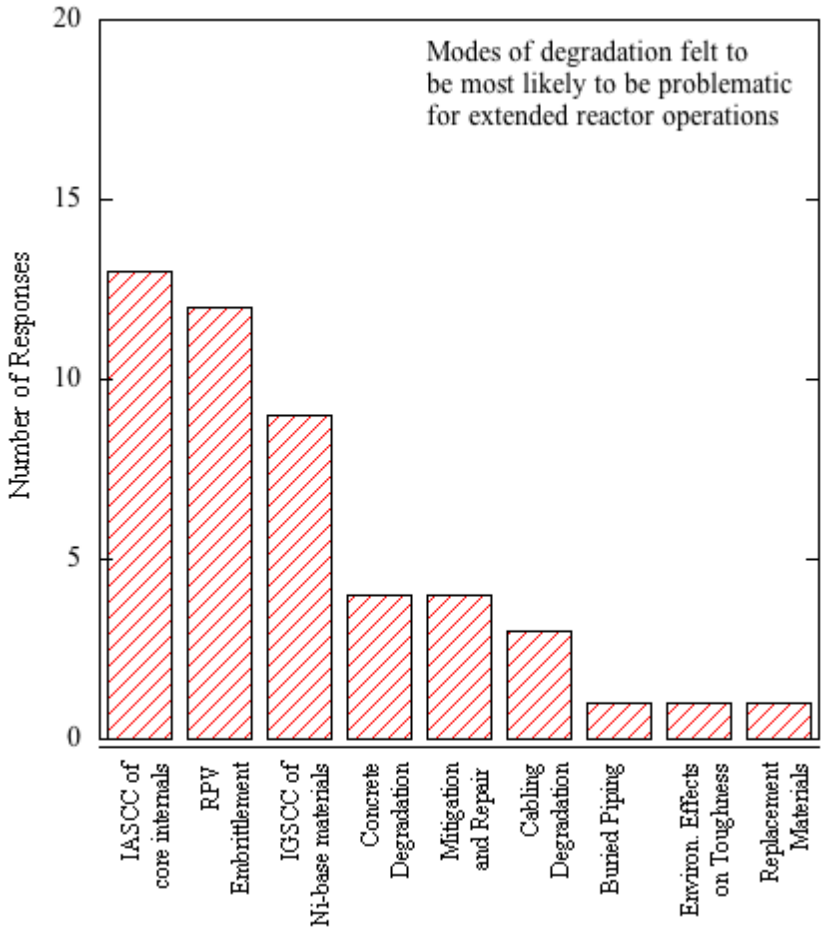

Figure 1. Summary of LWRS poll results on modes of degradation that are the most likely to be problematic for long-term operation of nuclear reactor power plants. Source: "Light Water

Reactor Sustainability Program: Materials Aging and Degradation Technical Program," Rev. 2, at 10 (August 2014) (Exh. NYS000485).

In short, EMDA and LWRS identify knowledge gaps with respect to irradiation-assisted materials degradation that are relevant to the safe operation of IP2 and IP3 for an additional 20 years. [redacted] NRC Staff believe that these knowledge gaps, and other relevant information developed by EMDA and LWRS, can simply be ignored. Indeed, despite numerous reports[6] and NRC Staff's own concession[7] that interacting aging effects are not well understood, Entergy proposes to operate IP2 and IP3 normally until synergistic degradation effects actually occur. Moreover, NRC Staff is content to simply wait for the possibly synergistic effects to manifest in an operating nuclear plant: "If synergistic effects of aging mechanisms were to occur, the resulting degradation will likely be found in at least one plant in the fleet." NRC PFT on NYS-25, at A204 (Exh. NCR000197). This approach is not "aging management," but a gamble at the expense of New York's citizens, economy, and environment.

[redacted] Entergy has known about this problem since it submitted its LRA in 2007, and flagged the issue in Appendix A, § A.3.2.1.4 of the LRA. [redacted]

[6] *See* Chen, et al., "Crack Growth Rate and Fracture Toughness Tests on Irradiate Cast Stainless Steels," NUREG/CR-7184, at xv (Rev. Dec. 2014) (Exh. NYS000488A); Trans. of Briefing on Subsequent License Renewal, at 77 (May 2014) (Exh. NYS000492); NUREG/CR-6909, Rev. 1, Draft, "Effects of LWR Coolant Environments on the Fatigue Life of Reactor Materials," at 11 (March 2014) (Exh NYS000490A); Chopra, O.K., "Degradation of LWR Core Internal Materials Due to Neutron Irradiation," NUREG/CR-7027, at 106-108 (December 2010) (Exh. NYS000487).

[7] NRC Staff PFT on NYS-25, at A195, A196, A200 (Exh. NRC000197).

[redacted] This commitment is indicative of Entergy's entire approach to safety, which is to wait for problems to appear before addressing them, and – even when a problem is apparent – commit only to monitor and study the problem, rather than fix it.

CONCLUSION

For the reasons described above, in addition to the various arguments raised in the State's prior submissions, Entergy has failed to submit a plan that adequately manages the effects of aging on RVIs, and its application to renew the operating licenses for Indian Point Unit 2 and Indian Point Unit 3 should therefore be denied.

Respectfully submitted,

Dated: September 9, 2015

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